Financing the Retrofitting of Hong Kong's Existing Buildings:

UNLOCKING ENERGY EFFICIENCY FOR CLIMATE AND ECONOMIC GOALS

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ABBREVIATIONS

BEEO	Buildings Energy Efficiency Ordinance
BEEAO	Buildings Energy Efficiency (Amendment) Ordinance
BEC	Building Energy Code
BIM	Building Information Modelling
BOOT	Build–Own–Operate–Transfer
BMS	Building Management System
CaaS	Cooling-as-a-Service
CAP2050	Hong Kong's Climate Action Plan 2050
CAPEX	Capital Expenditure
CCMS	Central Control and Monitoring System
CEPU Report	Report Commissioned by the Chief Executive's Policy Unit
CDI	Commercial Data Interchange (Hong Kong Monetary Authority)
CLP	CLP Power Hong Kong Limited and Castle Peak Power Company Limited
CO_2	Carbon Dioxide
COP	Co-efficient of Performance
DGS	Diocesan Girls School
DSS	Decision-Support System
DT	Digital Twin
EAC	Energy Audit Code
EaaS	Energy-as-a-Service
ECBs	Existing Commercial Buildings
ECM	Energy Conservation Measure
EMSD	Electrical and Mechanical Services Department
EPC	Energy Performance Contracting
ESA	Energy Service Agreement
ESCO	Energy Service Company
ESG	Environmental, Social and Governance
EUI	Energy Utilisation Index
FAU	Fresh Air Unit
FM	Facility Manager/Management
GFA	Gross Floor Area
GHG	Greenhouse Gas
HEC	Hongkong Electric Company Limited and HK Electric Investment Company
HKGBC	Hong Kong Green Building Council
HKGFA	Hong Kong Green Finance Association
HKMA	Hong Kong Monetary Authority
HVAC	Heating, Ventilation and Air Conditioning
IAQ	Indoor Air Quality
IRR	Internal Rate of Return
LSK	Lee Shau Kee Building (at HKUST)
M&V	Measurement and Verification
MRV	Measurement, Reporting and Verification
OPEX	Operating Expenditure
OPS	Onshore Power Supply
PACE	Property Assessed Clean Energy
PBC	Performance-based Contracting
$PM_{2.5}$	Particulate Matter with aerodynamic diameter less than 2.5 micrometres (fine particles harmful to human health)
PM_{10}	Particulate Matter with aerodynamic diameter less than 10 micrometres (coarse particles that can affect respiratory health).
REAs	Registered Energy Assessors
RICS	Royal Institution of Chartered Surveyors
ROI	Return on Investment
SME-ESCO	Small and Medium Enterprise Energy Service Company
SCAs	Scheme(s) of Control (agreements with power companies)

PREFACE

Since 2012, I have been on a long journey of learning about the importance of retrofitting buildings, both as a means to decarbonise and as a cornerstone of sustainable urban development. Over time, I have come to see these challenges holistically, and to believe there is a compelling case for a new policy narrative, in Hong Kong and beyond.

In dense cities like Hong Kong, buildings are far more than physical structures: they are personal and community assets. Many older buildings are still structurally sound and could endure for decades to come. Simply pulling them down and putting up new ones is not always possible, nor is it the most sustainable path. Retrofitting conserves resources, extends building life, and aligns with circular economy thinking. Yet laws, valuation practices, and financing systems too often favour new construction over renewal.

This imbalance is most visible in financing. Today, banks generally lend for retrofits against the collateral value of the property. But deep retrofits often do not translate into higher appraised values – surveyors rarely assign significant uplifts, even when efficiency and quality improve. Owners thus face a paradox: investing in retrofits produces social and environmental value, but insufficient financial recognition. By contrast, in other markets, infrastructure-style financing and certification schemes allow retrofitted or green-certified buildings to command better rents, higher occupancy, and asset price premiums. To unlock Hong Kong's retrofit potential, we must begin to shift away from collateral-based lending toward models that treat future savings and performance as bankable cash flows, much like infrastructure projects.

This report does not attempt to address all the dimensions of that shift. It focuses on one critical lever: performance-based contracting (PBC) as a financing mechanism that allows building owners to overcome the barrier of upfront capital. By tying repayment to verified energy savings, PBC creates the trust and transparency needed for owners, contractors, and financiers to share risks fairly.

Decarbonising buildings, however, cannot rest on individual projects alone. The scale and cost are too great. It requires collective effort from both the public and private sectors. What we need is an active retrofit market, where asset owners, financiers, and contractors are incentivised to act, where risks are shared transparently, and where government plays a catalytic role in de-risking and incentivising action.

The benefits extend beyond energy savings or carbon reductions. Retrofitting brings co-benefits to communities: improved indoor environments, healthier indoor air, and greater occupant well-being. These gains justify public support and highlight why retrofits should be seen not as a burden but as an opportunity to unlock value in Hong Kong's existing building stock.

My hope is that this perspective can help the HKSAR Government and market participants alike to craft a new policy narrative, one that recognises older buildings as valuable assets where fresh value can be unlocked through retrofitting in energy, and perhaps in other dimensions related to health and wellbeing as well.

It is encouraging that the Chief Executive's Policy Address 2025 included a statement that the HKSAR Government will be "driving the market to accelerate carbon reduction in existing buildings".

EXECUTIVE SUMMARY

Hong Kong's buildings account for over 90% of electricity use and about half of the carbon emissions. With most of today's stock still standing in 2050, large-scale retrofitting is indispensable for meeting climate goals, controlling energy costs, and maintaining the city's economic competitiveness. Retrofitting is not only a tool for carbon reduction and cost control: it conserves resources, extends the useful life of buildings, and reflects a circular economy approach that recognises older buildings as enduring community assets where fresh value can be unlocked.

Under the HKSAR Government's Climate Action Plan 2050, Hong Kong will phase out coal by 2035 and aims to achieve full decarbonisation of electricity supply by 2050, primarily through increased imports of clean energy from Mainland China. If fully realised and if building energy demand is also met entirely by electricity, the carbon intensity of Hong Kong's grid would in principle fall to zero, meaning buildings would no longer generate carbon emissions from energy use. The challenge, however, is that zero-carbon energy and its transmission to Hong Kong will be more expensive, possibly much more so. Retrofitting buildings is therefore critical both to cut emissions in the near term and to manage long-term costs, competitiveness, and resilience – not only in financial terms but also in ensuring buildings can continue to perform safely and efficiently under increasingly hotter and more variable climate conditions..

The challenge is not technology. Retrofit measures are well established to deliver returns. The barrier lies in finance, governance, and market design: fragmented ownership, high upfront costs, and weak trust in performance outcomes have left retrofitting voluntary and underdeveloped.

This report argues that retrofitting must be treated as a strategic necessity in Hong Kong's climate and economic agenda. The pathway to mainstreaming retrofit involves six interlinked pillars:

- Evidence and Data – A robust evidence base is required to estimate the size of the opportunity, reduce uncertainty, and support financial products. HKUST's Decision-Support System provides policymakers with a city-wide map of building energy use and retrofit scenarios, while the use of a Digital Twin platform validates outcomes at the building scale. Together, they offer useful insights for estimation.
- Financing Frameworks – Attractive returns exist, but capital must be mobilised. A *Retrofit Finance Platform* is needed to have an integrated ecosystem combining regulatory alignment, transparent performance data, and access to finance. Such a platform could eventually be anchored in the Hong Kong Monetary Authority's Commercial Data Interchange by linking the Electrical and Mechanical Services Department's new system of more frequent energy audit data (every 5-years) with bank lending processes. This would reduce transaction costs and create a transparent pipeline of bankable projects. Blended finance and aggregation mechanisms are required to enable participation by SMEs and small owners.
- Delivery Models – Performance-based Contracting (PBC) is the keystone model for Hong Kong because its various forms directly address high upfront costs, fragmented ownership, and weak market signals. By enabling Energy Services Companies to finance upgrades and recover costs from verified savings or fixed monthly fee, such contracts create confidence for owners, tenants, and financiers. Wide uptake requires greater familiarity, standardised contracts, simplified processes for smaller projects, and stronger government guidance.
- Demonstration is underway – Case evidence from commercial and institutional retrofits shows attractive payback periods, while also delivering important co-benefits notably improved indoor air quality, healthier environments, and reputational gains. These examples signal that retrofits are technically feasible, financially viable, and socially beneficial – which is why public policy focus and even for the government to provide incentives is appropriate.
- Public Sector Leadership – (a) Government can catalyse demand by using its own buildings as demonstrations, aggregating demand across schools, hospitals, and offices, and setting standards that can be replicated by the private sector; and (b) Consider publicly backed revolving guarantee schemes, which is most important to support smaller Energy Services Companies to participate, ensuring they can access capital and compete alongside larger players. By recycling

repayments into new projects, such schemes create a sustainable and scalable source of retrofit financing.

- Sustaining Performance – Buildings deliver value only if savings persist. Continuous commissioning, maintenance, physical and performance health audits, digital monitoring, and professionalised building management are essential for all buildings, including those which have undergone any form of upgrade or retrofit.

A STRATEGIC PATHWAY FOR HONG KONG

It is encouraging that the Chief Executive's Policy Address 2025 included a statement that the HKSAR Government will be "driving the market to accelerate carbon reduction in existing buildings". Hong Kong has the right ingredients for success. Hong Kong has a skilled engineering and contracting sector, deep capital markets, credible regulators, and emerging digital tools. But unlocking the city's retrofit potential requires treating it as a strategic pillar of climate policy, financial innovation, economic competitiveness and job creation.

The findings of this report point to a clear strategy:

1. Tighten and expand regulation under the Building Energy Efficiency (Amendment) Ordinance by shortening the energy audit reporting cycle from five to three years, introducing minimum energy performance standards, and triggering mandatory retrofit at point of sale or major renovation in the next term of administration (2026-2031).

2. Mobilise finance through performance-based contracting, public sector-backed revolving guarantees, incentives, and the creation of a *Retrofit Finance Platform*.

3. Leverage the public sector's building stock as a catalyst: performance-based retrofits of government offices, schools, hospitals, and infrastructure can provide demand certainty, demonstrate bankable models, and set benchmarks for the private sector.

4. Aggregate demand and simplify financing to include smaller asset owners who would otherwise be excluded.

5. Highlight case evidence from commercial, institutional, and heritage buildings showing attractive paybacks, healthier indoor environments (especially indoor air quality), and asset value gains, while portfolio analysis demonstrates how developers and investors are already treating retrofits as a strategic response to stranded asset risk.

6. Use the Decision-Support System to estimate and prioritize opportunities and integrate with audit data disclosed under the Buildings Energy Efficiency (Amendment) Ordinance to transform project assessment and financing.

7. Professionalise building management to sustain savings through training, accreditation, and operational best practice.

To date, retrofitting has not been explicitly embedded in the HKSAR Government's Climate Action Plan 2050. A future update should incorporate a clear role for retrofitting as a core pillar of Hong Kong's decarbonisation pathway. Importantly, retrofits deliver not only efficiency and carbon reductions but also co-benefits (especially indoor air quality) that extend beyond individual buildings to benefit the community. Yet, current collateral-based lending and valuation practices rarely capture these gains, meaning that government incentives and innovative financing models, particularly those that treat future savings as bankable cash flows, will be needed to mobilise investment at scale.

Sustaining retrofit performance will also require a stronger focus on building management. Without proper training and operational support, savings often drift after projects are completed. Developing a new generation of energy-literate building managers will be essential to lock in long-term gains.

Hong Kong has the engineering expertise, financial depth, and regulatory capacity to act. What has been missing is integration: a coherent strategy linking regulation, finance, technology, and management. With decisive leadership, retrofitting can become a cornerstone of Hong Kong's climate strategy, a visible expression of how sustainability, finance, and community well-being can be combined to create lasting value, and a flagship asset class in the city's green finance agenda to fully aligned with the Hong Kong Monetary Authority's 2024 Sustainable Finance Action Agenda, as well as align with the Chief Executive's Policy Address 2025.

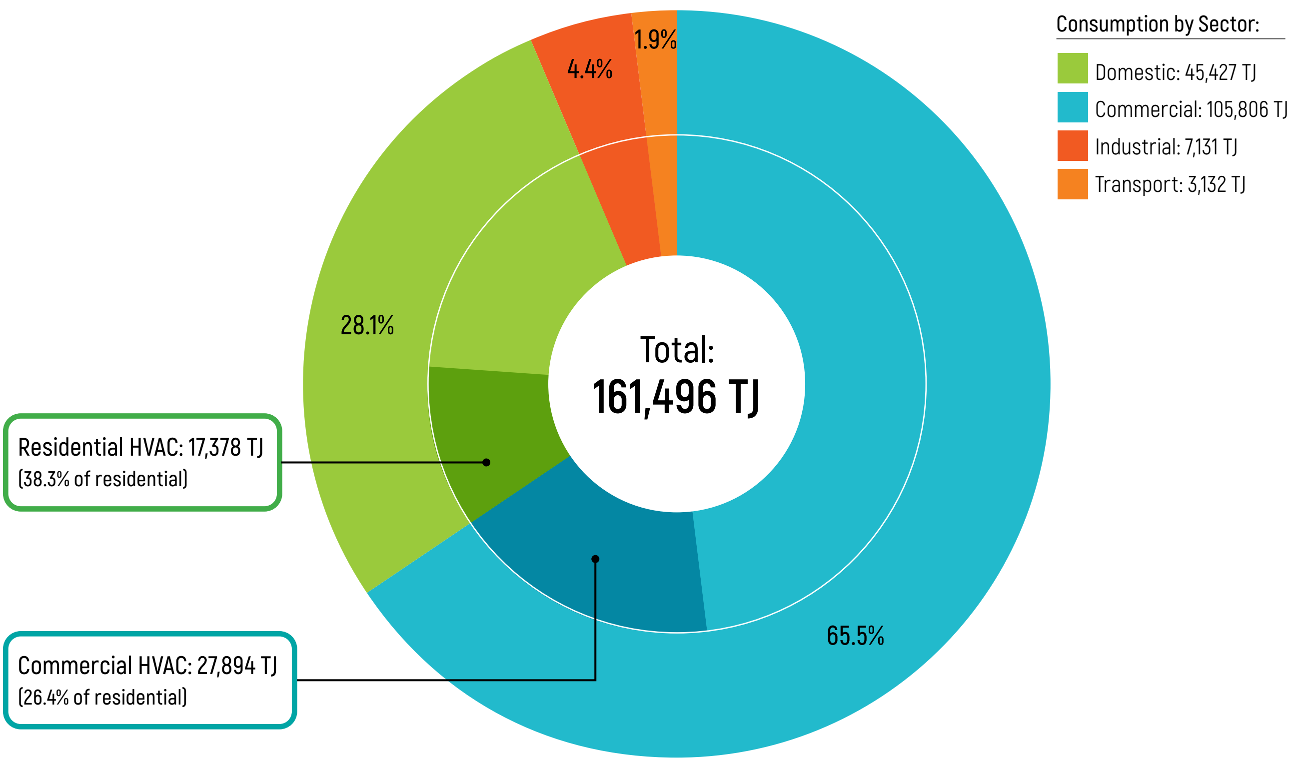
RETROFITTING BUILDINGS AND CLIMATE POLICY IN HONG KONG

Hong Kong is a vertical city. Its skyline of commercial towers and high-rise apartments is iconic, but behind these architectural feats lies an enormous energy footprint that represents both a climate challenge and a financial cost. The HKSAR Government has acknowledged this reality clearly:

> "Being an international financial and commercial centre, the majority of Hong Kong citizens' daily activities take place in skyscrapers. The resulting use of air-conditioners, lifts, lighting and various electrical appliances consumes a large amount of energy. Buildings account for about 90% of Hong Kong's total electricity consumption, and over 50% of our carbon emissions is attributable to generating electricity for our buildings. Achieving net-zero electricity generation requires enormous amount of capital and resources, and will increase the cost of electricity generation. Various sectors of the community and members of the public will inevitably have to share the cost. Through regulation as well as promotion and public education in energy saving, we can reduce the overall electricity consumption of buildings, and hence lower the cost of adopting new zero-carbon energy. This is conducive to maintaining Hong Kong's overall competitiveness in the global arena, in turn benefitting enterprises and citizens. The benefits will be even more significant if the amount of energy conserved exceeds the increase in the cost of achieving net-zero electricity generation".[1]

Figure 1 shows Hong Kong's electricity consumption by sector in 2022. Existing Commercial Buildings (ECBs) account for more than 65% of total demand, with Heating, Ventilation, and Air Conditioning (HVAC) systems alone responsible for more than a quarter. This concentration makes cooling systems a strategic target for retrofits.

FIGURE 1: HONG KONG ELECTRICITY CONSUMPTION 2022[2]



POLICY COMMITMENTS AND GAPS

Over the past decade, the HKSAR Government has issued two climate change plans. *The Climate Action Plan 2030+* (2017)[3] pledged to reduce absolute carbon emissions by 26%-36% and carbon intensity by 65%-70% by 2030 (relative to 2005 levels), explicitly highlighting retrofitting and retro-commissioning of existing buildings as major strategies. This emphasis was reinforced in the companion plan, *Deepening Energy Saving in Existing Buildings through the 4Ts Partnership* (2017),[4] which treated retrofitting as a key means to enhance efficiency and asset value.

By contrast, the *Climate Action Plan 2050* (CAP2050, 2021)[5] committed to achieving carbon neutrality before 2050 and halving absolute emissions before 2035, while setting electricity reduction targets of 30%-40% for commercial buildings and 20%-30% for residential buildings. These targets apply to both new and existing buildings, using 2015 operational conditions as the comparison baseline.

From 2015 to 2024, selected commercial buildings achieved an average 13% reduction in electricity use, but this modest progress does not reflect the broader market. As Ir Cary Chan, formerly of the Hong Kong Green Building Council (HKGBC), observed:

> "The majority of the existing building stock has not been following suit. Meeting the target in the climate change roadmap of reducing the energy intensity by 30%-40% for the whole building stock would thus be a huge challenge."[6]

However, under CAP2050, the rationale for building-related electricity targets is not only to reduce emissions but also to manage the expected rising cost of clean power. The HKSAR Government intends to phase out coal in electricity generation by 2035 and progressively expand the share of clean energy (nuclear and renewables) towards 2050. This transition is expected to be achieved largely through imports of clean energy from Mainland China under future Scheme of Control agreements (SCAs) with the two power companies CLP Power Hong Kong Limited and Castle Peak Power Company Limited (CLP) and Hongkong Electric Company Limited and HK Electric Investments Limited (HEC). If fully realised and provided that building energy demand is met entirely by electricity, the carbon emission factor of Hong Kong's grid would decline to zero, meaning that by 2050 buildings would no longer produce direct emissions from energy use. The challenge, however, is that clean electricity will likely be more expensive – perhaps much more – placing pressure on the city to curb demand through energy efficiency improvements and retrofits. As of the publication of this report, the details of future SCAs and the timeline for scaling up clean energy imports remain uncertain (as the new SCAs and imports of more clean energy from Mainland China have yet to be negotiated) leaving the precise balance between local generation and imports toward 2050 yet to be determined.

For households and tenants, the most direct efficiency lever lies not in large-scale retrofits but in the regular replacement of appliances. Labels have raised awareness, but international practice shows that greater impact comes when governments restrict or phase out the import of inefficient models altogether. Tightening minimum appliance efficiency standards, and signalling these in advance, would ensure that each new purchase contributes to long-term electricity savings, helping to deliver the residential sector's 20%–30% reduction target under CAP2050.

WHY RETROFITTING STILL MATTERS

Even if the carbon intensity of electricity would eventually fall to zero by 2050, retrofitting remains indispensable. There are three key reasons:

1. **Cost control:** Zero-carbon energy will probably be expensive. Reducing building electricity demand through retrofits helps contain future energy bills, safeguarding affordability for households and competitiveness for businesses.

2. **Near-term emissions reductions:** Until coal is fully retired, and natural gas electricity generation is much reduced, electricity savings directly reduce carbon emissions. Retrofitting therefore delivers meaningful reductions from the late-2020s through to the 2040s.

3. **System resilience and co-benefits**: Retrofitting could deliver additional benefits such as enhanced Environmental, Social and Governance (ESG) performance, creation of green assets, and broader sustainability gains.

4. **Climate resilient cities:** Healthier and safer buildings which can withstand the long-term impacts of a changing climate and serve the long-term interests of the population.

Globally, retrofitting is recognized as one of the most cost-effective levers for decarbonization. The World Economic Forum considered it a massive untapped opportunity in *Accelerating the Decarbonization of Buildings* (2022).[7] However, progress remains uneven across cities around the world due to a combination of financial, regulatory, and institutional barriers. This report identified common roadblocks, which included the lack of access to affordable capital, limited regulatory pressure to act, and fragmented decision-making between landlords, tenants, and investors.

Similarly, the World Green Building Council's *Building Transition: Financing Market Transformation* (2025)[8] stressed that since most buildings that will exist in 2050 are already built, retrofitting them is essential to avoid stranded assets and meet climate goals. This report called for inclusive financing models that support incremental improvements, particularly in low-performing buildings. Notably, it advocated for "zero-capital cost models with shared savings," allowing retrofits to proceed without upfront investment.

The World Resources Institute's *Hong Kong Energy Policy Simulator* confirmed that retrofits of existing buildings offer one of the largest single opportunities for cost-effective emissions reduction[9] although stronger retrofit policies and incentives would be needed.

These and other reports consistently highlight strong opportunities for energy savings lie in HVAC, lighting, and building envelope upgrades. Retrofits in these areas can deliver 20%–50% reductions in energy use, with payback periods varying by measure. Lighting and HVAC upgrades often yield attractive returns within just a few years, while envelope retrofits typically require longer horizons but add value in compliance, comfort, and asset resilience. In addition, emerging material technologies, such as radiative cooling paints and films, offer quick-wins as low-cost solutions that can further reduce HVAC demand with minimal disruption.

CURRENT INCENTIVE SCHEMES SUPPORTING RETROFITS

Beyond regulatory requirements, incentive schemes under the current SCAs provide useful support for retrofits and energy efficiency improvements. As of December 2024, these include:

1. Community Energy Saving Fund (CLP) and Smart Power Care Fund (HKE): CLP contributed more than HK$865 million since 2018, benefitting about 2.5 million households and 24,000 SMEs, with savings of over 162 million kWh of electricity. HKE contributed HK$120 million, supporting 160,000 households and 400 SMEs, with savings of over 530,000 kWh. In 2025, CLP and HKE earmarked over HK$240 million and HK$41 million respectively for new energy-saving and carbon-reduction projects, such as energy-efficient equipment upgrades, renewable energy adoption, and support for social welfare organisations and schools.

2. New Energy Efficiency Fund (CLP's Eco Building Fund / HKE's Smart Power Building Fund): Allocating HK$100 million (CLP) and HK$25 million (HKE) annually, these funds subsidise energy efficiency improvement in shopping malls, common areas of residential estates, and commercial/industrial buildings. By December 2024, about 6,000 buildings had benefitted, with estimated savings of 540 million kWh annually, equivalent to the electricity consumption of around 165,000 households.

3. Energy auditing services: Both CLP and HEC provide free audits for non-residential customers, covering around 800 buildings per year (600 by CLP and 210 by HKE). If all recommended measures are implemented, these audits could save about 50 million kWh annually, equivalent to the consumption of 15,000 households.

These schemes demonstrate that incentives can achieve measurable energy savings at scale while reaching households, SMEs, and community organisations. They provide a valuable complement to regulatory measures by reducing financial barriers, raising awareness, and creating early momentum for retrofits.[10]

BARRIERS TO RETROFIT UPTAKE

Despite the clear economics, retrofitting in Hong Kong remains a voluntary, fragmented activity. Key barriers include:

- High upfront capital costs that deter owners, especially in older or multi-owner buildings.
- Split incentives between landlords and tenants, where owners fund upgrades but tenants capture savings.
- Fragmented ownership structures, particularly in strata-title buildings.
- Lack of regulatory pressure to mandate or accelerate action.
- Low awareness and technical capacity among most building owners and managers.

These barriers are not unique to Hong Kong. Globally, retrofitting existing buildings is recognised as one of the most urgent and unavoidable decarbonisation tasks, requiring trillions of dollars in investment between now and 2050. Because most of today's building stock will still be in use mid-century, efficiency gains cannot be deferred; they must be achieved quickly and at scale if climate and economic goals are to be met. These issues point directly to the importance of Performance-Based Contracting (PBC), discussed in Chapter 2, which can help to realize the Chief Executive's Policy Address 2025 statement that the HKSAR Government will be "driving the market to accelerate carbon reduction in existing buildings".[11]

The decisive factor is not technology but finance – specifically, the ability of financial and contractual models to mobilise both public and private capital. Experience shows that attractive payback periods are not enough on their own (see Chapter 5); owners, contractors, and financiers must all have confidence that outcomes will be delivered, and disputes avoided (see Chapter 9). This requires PBC arrangements, such as Energy Performance Contracting (EPC) and its variants that set out clear baselines, allocate risks transparently, and establish trusted mechanisms for verifying results. Where these conditions are met, capital can flow at scale.

EVIDENCE FROM OTHER RECENT REPORTS

A growing body of research points to the same conclusion: while technical potential is strong, institutional alignment is lacking.

Civic Exchange and Hong Kong Green Finance Association's (HKGFA) *Decarbonising Hong Kong Buildings: Policy Recommendations and Next Steps* (2020)[12] highlighted a persistent policy vacuum in which retrofitting is neither mandated nor adequately incentivized. The report pointed to the absence of a long-term roadmap for upgrading existing buildings and stressed the need for mandatory energy performance disclosure, financial incentives, and integrated financing mechanisms.

The Royal Institution of Chartered Surveyors (RICS) in its *Decarbonising the Built Environment in Hong Kong: How can Hong Kong reach its decarbonization goals?* (2023)[13] identified several persistent shortcomings: despite the adoption of BEAM Plus certifications and mandatory energy codes, gaps remain in integrating renewable energy, enhancing resilience, and increasing public awareness. RICS called for regulatory standards aligned with international norms, lifecycle carbon assessments, and mandatory carbon reporting for building owners. These measures, it argued, are foundational to creating market discipline and transparency.

The *Retrofitting Guidebook* (Version 2) by HKGBC of 2024[14] added further clarity. While largely focused on the engineering side of retrofit implementation, the guidebook acknowledged two critical market failures: the high upfront cost of retrofitting and the persistent misalignment of incentives between landlords and tenants. The guidebook made clear that in Hong Kong's commercial property market, it is typical for landlords to bear the capital cost of retrofits while tenants reap the benefits in lower electricity bills. Without regulatory or leasing reforms to address this mismatch, most retrofits remain economically unattractive to building owners. The HKGBC has also launched the Retrofitting Hub in 2025 as an online knowledge platform for sharing information including latest retrofitting strategies, guidelines, case studies, resources and activities

Further, the *Hong Kong Report on the State of Sustainable Built Environment 2024*, also released by the HKGBC,[15] reiterated the energy savings potential of retrofitting and provides updates on over 100 technology-enabled projects. While these projects showed promise, ranging from smart building management to energy-efficient HVAC systems, the report acknowledged that systemic change was still lacking. Financial mechanisms like

The Hong Kong Green Building Council (HKGBC)

HKGBC is a non-profit, member-led organisation established in 2009 and has become a public body under the Prevention of Bribery Ordinance since 2016. The HKGBC strives to promote the standard and development of sustainable buildings in Hong Kong. The HKGBC also aims to raise green building awareness by engaging the government, the industry and the public, and to develop practical solutions for Hong Kong's unique, subtropical built environment of high-rise, high density urban area, leading Hong Kong to achieve carbon neutrality by 2050 and to become a world's exemplar of green building development. The Founding Members of the HKGBC include the Construction Industry Council, the Business Environment Council, the BEAM Society Limited and the Professional Green Building Council.

To learn more about HKGBC, please visit http://www.hkgbc.org.hk.

The Hong Kong Green Finance Association (HKGFA)

HKGFA, founded in September 2018, provides a unique platform that supports the development of green finance and sustainable investments in Hong Kong and beyond. It aims to mobilise both public and private sector resources and talents in developing green finance policies, to promote green finance business and product innovation within financial institutions. HKGFA's main goal is to position Hong Kong as a leading international green tech and green finance hub by providing greater access and opportunities for Hong Kong's financial institutions and corporates to participate in green financing transactions locally, in Mainland China, and in markets along the Belt & Road. This is in line with the global path to implementing the UN Sustainable Development Goals and the Paris Agreement.

HKGFA's key activities are organised through five working groups, namely Banking – Financing the Transition, Product Innovation and Solutions, Sustainability-related Disclosures, Policy and Standards, Greater Bay Area Green Finance Alliance, and Real Estate.

To learn more about HKGFA, please visit https://www.hkgreenfinance.org.

green loans or performance-based contracts were underutilized, and retrofitting remained inaccessible to small and mid-tier owners.

Similarly, the property management company, Savills' 2024 roadmap report, *Decarbonising Hong Kong: Roadmap to a World Class Metropolis*,[16] emphasized that despite strong foundations (technical expertise, financial depth, and policy frameworks) Hong Kong's building sector lacked the institutional alignment and financial incentives to mainstream retrofitting. Key barriers included misaligned valuation mechanisms, insufficient data transparency, and a lack of education around sustainability. Their report called for coordinated industry collaboration and regulatory interventions that tie finance to performance outcomes.

In 2025, real estate firm JLL highlighted in its report *Hong Kong must increase retrofit rate to reach net-zero targets*[17] that Hong Kong needed a coordinated financing strategy to increase the pipeline of bankable retrofit projects, without which it would deter institutional investors, who seek scale, predictability, and policy clarity.

A joint report issued by the consulting firm ARUP and Civic Exchange in 2024 noted that retrofitting had not been incorporated into CAP2050.[18] The authors proposed a series of corrective measures, including the establishment of a dedicated retrofit fund, stronger regulatory signals, and integration of retrofitting into the city's innovation and finance agendas.

CWR, a non-profit that focuses on environmental and climate risks in Asia, offered another critical perspective in *Beyond Net Zero in Hong Kong: Much to Lose by Doing Nothing and Everything to Gain by Doing Something* (2025).[19] Its analysis emphasized the city's reactive posture. Instead of designing proactive policies to drive retrofit uptake, the government and market participants often responded passively to external pressure or building-level crises. The paper argued that retrofitting should be treated as a core resilience strategy, not an optional upgrade. By doing so, it could also unlock co-benefits such as water conservation, indoor air quality improvements, and enhanced public health outcomes.

HSBC highlighted that globally the building sector requires an estimated US$10 trillion by 2030 and US$29 trillion by 2050 in transition capital to align with the Paris Agreement in its 2025 report *Decarbonising the built environment: Perspectives from Hong Kong and mainland China*.[20] This scale of investment underscores the need for close public-private collaboration, given that buildings are both long-lived assets and critical to economic and climate resilience.

The financing dimension is therefore critical. The HKGFA White Paper, *Activating the Retrofitting Market in Hong Kong*, published on 8 September 2025 identified pathways for mobilising capital toward retrofits.[21] This report is discussed more fully in Chapter 4.

The consensus across all the reports noted above is clear: Hong Kong has the technology, finance, and expertise, but lacks institutional alignment and financial mechanisms to mainstream retrofits.

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HONG KONG LITERATURE ON ENERGY PERFORMANCE CONTRACTING

Financing remains one of the most persistent barriers to scaling retrofits in Hong Kong. High upfront capital expenditure (capex), coupled with split incentives between landlords and tenants, often deters owners from undertaking upgrades even when paybacks are attractive. A proven mechanism to overcome this challenge is PBC, in which repayment is tied to verified performance outcomes. Within this broad category, EPC has been the most researched model in Hong Kong. Chapter 4 introduces variant forms of PBC that have emerged. In all cases, PBC enables third-party Energy Service Companies (ESCOs) to finance, implement, and guarantee savings from retrofit projects, thereby shifting much of the capex burden away from building owners while aligning incentives through outcome-based returns.

HONG KONG EPC RESEARCH

Over the past two decades, Hong Kong has produced a small but valuable body of scholarly and policy-relevant literature on EPC, examining its concept, practical implementation, and the challenges of applying it in the local context. This body of work spans from early technical pilots to more recent risk-based frameworks, revealing both a gradual deepening of technical and policy understanding and the persistence of institutional barriers that have constrained wider adoption. Reviewing these studies offers more than a historical perspective: it provides insight into how local experience has shaped knowledge about PBC, which barriers have proven most intractable, and which proposed solutions have recurred across time.

By comparing five key Hong Kong-relevant studies – Mary Wan Yeung (2000),[22] Sam Hui (2002),[23] Raymond Poon (2005),[24] Pan Lee (2015),[25] and the commissioned study by the Chief Executive's Policy Unit on retrofit (2024)[26] – this chapter analyses their respective purposes, observations, identified challenges, and recommended solutions, highlighting lessons that remain relevant to current policy and market development.

1. Wan Yeung (2000): Delivering on Promises through Pilot Projects

Mary Wan Yeung's 2000 MSc dissertation, written while serving as a government official, is an early detailed account of EPC practice in Hong Kong. Her study examined a pioneering EPC pilot at the United Christian Hospital in Kwun Tong, conducted as part of the Electrical and Mechanical Services Department's (EMSD) efforts to explore performance-based energy efficiency in public buildings. The aim was to test EPC's feasibility in a local institutional context, and to determine how contracts, baselines, and savings verification could be structured to meet both technical and administrative requirements.

The hospital project used a defined baseline period from September 1995 to August 1996, adjusting for weather, occupancy, and load changes. Savings were tracked through rigorous Measurement and Verification (M&V) procedures,[27] supported by independent audits, and the results confirmed that EPC could deliver measurable, reliable energy savings in Hong Kong. Wan Yeung's treatment of the pilot makes clear her professional confidence in EPC as a useful tool for the territory's energy efficiency goals.

At the same time, her analysis points to a set of practical issues that, if left unaddressed, could constrain wider adoption. She highlighted low awareness of EPC among building owners, the absence of standardised contracts and locally adapted M&V protocols, and the misalignment between existing public procurement frameworks and EPC's performance-based, risk-sharing structure. While she did not explicitly frame her support for EPC as conditional, the sequencing of her discussion (pilot success followed by targeted recommendations) conveys the message that EPC's potential would only be fully realised if such enabling measures were put in place.

Her recommendations included expanding the use of public sector pilots to build familiarity and trust, developing standardised contractual clauses and M&V protocols tailored to Hong Kong's conditions, and strengthening institutional capacity for monitoring and auditing. As a senior practitioner in the public sector, Wan Yeung saw government-led projects not only as a proving ground for EPC but as an essential driver for building the competence and confidence needed to sustain the model in Hong Kong.

2. Hui (2002): Market Potential and Sectoral Focus

Sam C. M. Hui's 2002 study, produced while he was a researcher in the Department of Mechanical Engineering at The University of Hong Kong, shifted the local EPC discussion from testing feasibility to evaluating market potential. His work set out to assess the scale of opportunity for EPC in Hong Kong's building sector and to identify the types of buildings most likely to benefit. Drawing on energy use data, building typologies, and sectoral characteristics, Hui concluded that large, owner-occupied, and energy-intensive buildings, particularly hospitals, hotels, and universities, offered the best starting points for EPC projects. These settings combined high HVAC loads with decision-making structures where the same entity could invest capital and directly capture operational savings, avoiding the landlord–tenant split incentive that hampers many commercial buildings.

Hui's analysis confirmed EPC's technical viability but made clear that realising its potential would require careful targeting. While he did not portray EPC adoption as contingent on broad institutional reform, his emphasis on selecting the "right" sectors implicitly acknowledged the structural and behavioural constraints that could limit uptake. These included reluctance among building owners to enter long-term agreements for unfamiliar services, perceptions of contractual complexity, and a lack of familiarity with M&V requirements. The landlord–tenant divide in much of Hong Kong's commercial building stock was singled out as a particularly stubborn barrier, as energy savings often accrue to parties other than those making the capital investment.

Rather than prescribing sweeping policy changes, Hui's recommendations focused on pragmatic, sector-specific strategies. He advised targeting early efforts on the high-potential sectors he had identified, where the alignment between investment and benefit would be strongest. He also pointed to the EMSD and the city's utilities (i.e. CLP and HEC) as possible facilitators, able to offer technical expertise, act as trusted intermediaries, and help overcome the unfamiliarity that discouraged some building owners from engaging in EPC. In this way, Hui's work positioned EPC not as a one-size-fits-all solution, but as a market mechanism whose success in Hong Kong would depend on focusing on the right niches and building the confidence of key stakeholders.

3. Poon (2005): Public Sector as Market Catalyst

Raymond Poon's 2005 work, written in his capacity as an officer of the EMSD, examined EPC from the vantage point of government as both a major building owner and a potential market shaper. His study reviewed a series of EMSD-led EPC pilot projects, including police stations, hospitals, and sports facilities, undertaken to test PBC in different operational contexts. These pilots, Poon argued, demonstrated that EPC could deliver tangible and verifiable energy savings in Hong Kong's public buildings, while also signalling government commitment to energy efficiency. This, in turn, had the potential to stimulate private sector interest and engagement.

Poon's analysis supported expanding EPC use, but his vision for scaling was clearly tied to structural changes within the public sector. He noted that existing procurement procedures were poorly suited to EPC's performance-based payment mechanisms and risk-sharing arrangements. There was also no centralised set of government-endorsed M&V guidelines or standard contract templates, meaning that each project had to negotiate terms from scratch – a process that increased transaction costs and complexity. The pool of private sector ESCOs with EPC experience was small in Hong Kong, limiting market capacity for delivery at scale.

Poon's recommendations reflected both a belief in EPC's value and a pragmatic understanding of the institutional adjustments needed for it to thrive. Poon called for the institutionalisation of public sector EPC programmes, complete with dedicated budgets and energy-saving targets; the development of standardised, government-backed contract and M&V templates; and the creation of formal mechanisms for transferring lessons learned from public pilots to the private sector. In his framing, the public sector was not merely another client for EPC but a market catalyst – capable of leading by example, setting standards, and creating the confidence and consistency that would allow EPC to take root in Hong Kong's broader building market.

BOX 1
EPC in Practice – Contrasting Outcomes in Hong Kong Hospitals (Wan Yeung 2000; Poon 2005)

Hong Kong's early experience with EPC illustrates why PBC succeeds in some cases but fails in others. Two hospital projects, one unsuccessful, one successful, provided useful lessons:

- **United Christian Hospital** (Wan Yeung, 2000): This EPC project became a cautionary tale. Disputes arose over how to establish the baseline of energy consumption and verify savings, leaving the client and ESCO in conflict. Institutional barriers in procurement and accounting compounded the problem. With risk allocation and outcome verification poorly defined, the project ended in dissatisfaction and eroded trust in EPC.
- **Kwong Wah Hospital** (Poon, 2005): In contrast, the EPC project here was widely regarded as a success. The contract adopted phased implementation and clear baseline adjustment mechanisms, with a carry-forward approach for excess or shortfall in savings. Collaboration among the Hospital Authority, hospital management, and the ESCO reduced mistrust, while guaranteed savings and utility contributions underpinned financial viability.

These cases show that EPC is not primarily a technical challenge. Success or failure hinges on the clarity of contractual arrangements, particularly around baselines, measurement, and risk-sharing. Without trust and transparent mechanisms, even technically sound projects may collapse; with them, EPC can deliver durable savings.

4. Lee (2015): Towards a Hong Kong-Specific EPC Framework

Pan Lee's 2015 doctoral dissertation was a comprehensive study of EPC in Hong Kong. From the outset, Lee was clear that EPC had not yet achieved its potential in Hong Kong, despite its proven technical feasibility. Many of the same barriers identified in earlier studies persisted: low awareness among building owners; unfamiliarity with EPC's contractual structure; a lack of standardised, locally relevant M&V guidelines; and public procurement systems misaligned with performance-based risk-sharing arrangements. In addition, Lee identified high transaction costs and uncertainty in savings estimation as major deterrents to both building owners and financiers – issues that, without resolution, would keep EPC from scaling beyond niche applications.

A distinctive contribution of Lee's work was his integration of advanced technical modelling into EPC risk assessment. He developed a Hong Kong-specific EPC model that incorporated risk quantification. This approach allowed stakeholders to model energy savings under different operational and environmental conditions, quantify the probability distribution of outcomes, and therefore negotiate contract terms based on a shared understanding of potential variability. By introducing this probabilistic perspective, Lee addressed a central concern in EPC – the allocation of performance risk – with a tool that could build confidence between clients and ESCOs.

Lee's comparative analysis of EPC in other jurisdictions revealed several transferable lessons: the value of standardised contracts and procurement guidelines; the aggregation of smaller projects to achieve economies of scale; and the role of government as both facilitator and market participant. He stressed that these measures needed to be adapted, not imported wholesale, to fit Hong Kong's legal framework, institutional culture, and building market structure.

Lee's recommendations reflected a dual emphasis on technical precision and institutional reform. On the technical side, he proposed adopting probabilistic modelling as a standard part of EPC project development in Hong Kong, supported by publicly available tools and training. On the institutional side, he called for the creation of government-backed standard EPC contracts, sector-specific M&V protocols, and procurement procedures designed to accommodate PBC. He also urged policymakers to encourage project bundling, particularly for smaller public buildings and schools, to reduce transaction costs and make projects attractive to ESCOs and financiers.

TABLE 1: COMPARATIVE SUMMARY OF 4 REPORTS 2000-2015

Author & Years	Purpose	Observations	Problems & Challenges	What works/should work	HK Context
Wan Yeung (2000)	Test EPC feasibility via public hospital pilot; detail contract, baseline, M&V	EPC viable with robust M&V; public pilots build trust	Low awareness; no standard contracts; procurement misalignment	Rigorous baseline & audit; public sector pilots	Public hospital project
Hui (2002)	Assess market potential and sector focus	Large, ageing, owner-occupied buildings ideal for EPC	Owner reluctance; legal complexity; split incentives	Target high-potential sectors; EMSD-utility partnerships	Local building stock & energy patterns
Poon (2005)	Show public sector's role in market development	Public pilots prove EPC across building types	Procurement misalignment; lack of guidance; limited private capacity	Institutionalise public EPC programmes; government templates	EMSD-led police, hospital, sports facility cases
Lee (2015)	Develop HK-specific EPC framework with risk tools	Barriers persist; procurement/M&V gaps; need adaptation of global best practice	Transaction costs; savings uncertainty; no aggregation	Standardised contracts; risk modelling; project aggregation	Local cases plus comparative international models

Taken together, the four studies presented a consistent picture of EPC's potential and its enduring barriers in Hong Kong. The same themes recur: the technical feasibility of EPC, the need for standardised M&V and contractual frameworks, misalignment with public procurement systems, and the importance of government leadership in market development.

CHIEF EXECUTIVE'S POLICY UNIT (2024): PRE-POLICY RESEARCH

The Chief Executive's Policy Unit commissioned the *Study on Energy Efficiency Retrofitting of Existing Buildings for Carbon Neutrality in Hong Kong : Policy Recommendations and Guidelines for Overcoming Challenges* (CEPU Report)[28], which focussed primarily on office buildings, the segment with the highest energy intensity and largest retrofitting potential. The report confirmed that large-scale retrofitting is indispensable if Hong Kong is to achieve carbon neutrality before 2050, and it systematically examined financial, technical, institutional, regulatory, and social barriers. Among the most critical challenges identified were high upfront investment costs, limited access to affordable finance, low stakeholder awareness and motivation, weak government incentives, long audit cycles with little follow-through, and the absence of robust benchmarks to compare building performance. To overcome these barriers, the CEPU Report made three overarching sets of recommendations:

1. Tighten regulatory requirements and improve transparency – shorten the energy audit cycle from ten to five years (and eventually to three); enhance disclosure of building performance; require proposals for improvement after audits; establish performance benchmarks; and mandate retrofits for underperforming buildings.

2. Build capacity and awareness – provide regular education and training programmes for facility managers, building owners, and occupants, in collaboration with industry bodies such as HKGBC, alongside broader public awareness campaigns.

3. Offer financial and non-financial incentives – expand subsidy schemes, consider tax rebates and low-interest loans, provide free audits for small owners, and introduce recognition such as certificates for buildings achieving strong performance.

Importantly, the CEPU Report also discussed EPC as a financing model to help overcome the high upfront costs of retrofits. It highlighted the role of ESCOs in financing, implementing, and guaranteeing energy savings, with repayment made from the verified savings achieved. The inclusion of EPC signals recognition of performance-based models as part of the solution to Hong Kong's retrofit challenge.

For the purposes of this present report, the CEPU Report is highly relevant. It provides evidence of both the urgency and the systemic barriers to retrofitting existing buildings in Hong Kong. By highlighting regulatory tightening, disclosure, incentives, and education, while also acknowledging EPC as a viable contracting mechanism, it complements this present report's argument that finance, and market design must be aligned with policy reform to unlock large-scale investment.

CONCLUSION

The review of contracting experience confirms that PBC can be a powerful mechanism to overcome capital barriers and deliver measurable energy savings. Yet the evidence also shows that technical potential alone is insufficient. Projects succeed or fail primarily on the strength of their contractual design. Hong Kong's early EPC trials illustrated this clearly. The lesson is unambiguous: contractual clarity, not just technical measures, determines whether EPC and its variants create trust or conflict.

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HONG KONG RECENT EFFORTS TO SCALE UP BUILDING RETROFITTING

Building confidence in financing mechanisms, such as PBC, is necessary but not sufficient. Without a supportive policy and governance framework, the retrofit market in Hong Kong will remain underdeveloped. Government plays a critical role in creating the conditions for investment by setting clear targets, mandating disclosure and standards, and aligning incentives across landlords, tenants, and financial institutions. Yet, as seen in CAP2050, retrofitting has not been given the same policy visibility as other measures. This chapter examines how governance, regulation, and institutional leadership are evolving to close that gap and that the time is ripe for the HKSAR Government to take another step forward.

New impetus in the Chief Executive's Policy Address 2025 to accelerate carbon reduction in existing buildings will no doubt be helpful going forward.

POLICY CONTEXT AND THE BEEO'S ORIGINAL LIMITATIONS

The Buildings Energy Efficiency Ordinance (BEEO), implemented in 2012, was a significant step in requiring minimum energy performance standards. It applies to 13 types of prescribed buildings, covering building services installations i.e. air-conditioning, electrical, lighting, lift and escalator installations when buildings are newly constructed or when major retrofitting works are carried out.

Under the BEEO, "major retrofitting works" include the works involving addition or replacement of a building services installation that covers one or more places with a floor area or total floor area of not less than 500 m^2 under the same series of works within 12 months in prescribed building; and addition or replacement of an electrical circuit rated 400A or above, an air-conditioning unit rated 350kW or above, and lift or escalator motors or mechanical drives. This captured some large-scale retrofits but left many smaller upgrades outside regulatory oversight.

In addition, the BEEO required only two types of buildings – commercial buildings and portions of composite buildings that are for commercial use – to conduct energy audits at least once every 10 years. Compared with international practice, this left major gaps in coverage and frequency, limiting the BEEO's effectiveness in driving sustained retrofit activity.

As discussed in Chapter 2, the CEPU Report provided the most comprehensive pre-policy research on retrofitting to date. It identified gaps in the BEEO, such as limited building coverage, long audit cycles, and weak performance disclosure, and recommended reforms to expand scope, shorten intervals, and mandate data transparency. The CEPU Report also called for integration of EPC into compliance pathways and parallel financial incentives, measures that remain absent from the current framework.

CHIEF EXECUTIVE'S POLICY ADDRESS 2023 & PUBLIC CONSULTATION

In the October 2023 Policy Address, the HKSAR Government announced its intention to amend the BEEO to enhance energy conservation and decarbonisation in buildings.[29] The EMSD followed in November 2023 with a public consultation that proposed the following key reforms:[30]

1. **Expanding coverage of energy efficiency standard regulation to data centre** – extending requirements to new constructed data centre building and major retrofitting works in existing data centre building (including data centre in industrial building).

2. **Expanding coverage of energy audits** – extending requirements beyond the existing two categories (commercial buildings and commercial portions of composite buildings) to a much broader set of building types.

3. **Shortening the audit cycle** – reducing the interval for mandatory audits from once every 10 years to once every 5 years, aligning with international best practice.

4. **Mandating disclosure of technical information** – requiring more detailed reporting on building services installations to enhance transparency and enable better market response.

These proposals echoed the CEPU Report's recommendations in principle, particularly on coverage and transparency. However, the CEPU Report had gone further, recommending mandatory annual disclosure of the Energy Utilisation Index (EUI)[31] for all ECBs above a specified floor area. The CEPU Report argued that such disclosure was critical for competitive benchmarking, sustainability-linked financing, and performance-based leasing.

CODES OF PRACTICE: BEC 2024 AND EAC 2024

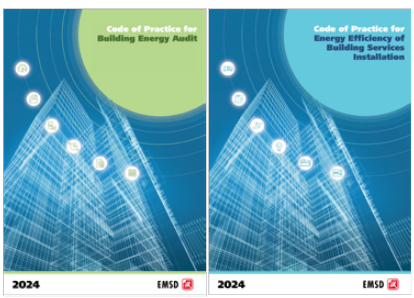
In parallel, EMSD updated the technical codes of practice that underpin the BEEO once every three years since 2012:

- BEC 2024 *(Code of Practice for Energy Efficiency of Building Services Installation)* sets minimum performance standards for air-conditioning, electrical, lift and escalator, and lighting installations. Reviewed on a triennial cycle, the 2024 edition was gazetted on 22 November 2024. It raised efficiency standards by more than 20% compared with the 2015 baseline, with full implementation after a grace period ending in August 2025.

- EAC 2024 *(Code of Practice for Building Energy Audit)* specifies the methodology and reporting requirements for energy audits of central building services installations. Revised in 2024, it improves audit consistency and comparability by introducing standardised energy audit report template to facilitate systematic data analysis.

Looking ahead, EMSD could further strengthen the BEC's role by publishing indicative 'forward trajectories' of expected standards for the next revision cycle. Providing owners and service providers with advance visibility of likely future requirements would stretch ambition, encourage early adoption of higher-efficiency technologies, and reduce the risk of incremental compliance upgrades that quickly become outdated.

Together, BEC and EAC form the technical backbone of the legal framework: the former ensures that new works and major retrofits meet modern efficiency standards, while the latter ensures that audits of existing buildings produce usable, transparent performance data.[32] Complementary demand-side measures, such as tightening appliance efficiency standards and restricting the import of inefficient models, could further reinforce these codes by driving sustained electricity savings in the residential sector alongside building-level improvements.



THE BUILDINGS ENERGY EFFICIENCY (AMENDMENT) ORDINANCE (BEEAO) 2025

Following the EMSD consultation, the HKSAR Government introduced the Buildings Energy Efficiency (Amendment) Bill 2025, gazetted on 21 March 2025 and passed in June 2025. The reforms:

1. Expanded scope of energy efficiency standard regulation – requirements extended from 13 to 15 building types by adding two new categories, including data centre building and data centre inside industrial building.

2. Expanded scope of energy audits – requirements extended from two to 11 building types by adding nine new categories, including education, community, municipal services, medical and healthcare, government-use buildings, airport passenger terminals, and railway stations, as well as stand-alone data centres and portions of industrial buildings converted into data centres.

3. Shortened audit intervals – audits must now be conducted every five years rather than every 10.[33]

4. Disclosure of technical information – energy efficiency related data of major building services installations (e.g. efficiency coefficients, age, control systems, and energy-saving potential) will be disclosed to the public by EMSD to improve transparency and stimulate retrofit activity.

With exemptions in place for smaller buildings with GFA not exceeding 7,000 m^2, except data centres, the HKSAR Government estimates that around 3,000 buildings will ultimately be subject to regular audits under the BEEAO (up from about 2,700 previously). Data centres are explicitly not exempt, as their electricity intensity is at least ten times higher than other building types.

Once fully implemented, the new regime is projected to save about 500 million kWh annually by 2035, equivalent to the annual electricity consumption of roughly 150,000 households. Since the BEEO first took effect in 2012, around 2,700 buildings have already completed their first energy audits, with over half completing a second. EMSD's analysis shows that the EUI of these buildings declined by about 20% on average between the first and second audits, clear evidence that audits can help drive meaningful efficiency improvements.

IMPLEMENTATION AND INDUSTRY SUPPORT

In parallel with legislative and technical reforms, EMSD has emphasised the importance of supporting industry adaptation. It plans to release explanatory materials and case studies, provide workshops and technical guidance for Registered Energy Assessors (REAs),[34] and make use of energy data to strengthen benchmarking. A phased commencement schedule, with new REA qualifications taking effect within three months of passage (i.e. on 20 September 2025), and the wider provisions after 15 months of passage (i.e. 20 September 2026, is intended to give building owners and contractors sufficient time to adjust to the new compliance environment. EMSD committed to standardising audit report formats and developing streamlined reporting procedures, alongside providing technical support where needed to reduce administrative costs, improve efficiency, and ensure the new regime is both practicable and effective.[35] This commitment was fulfilled and launched for compulsory use from 1 June 2025.

In addition, EMSD will not reject voluntary energy audits conducted for buildings not required to audit under the BEEO, such as hotels. Although such buildings are not required to submit audit reports, many organizations not required to submit audit reports have already carried out audits by referring to the EAC. EMSD plans to develop a voluntary scheme to encourage buildings outside the BEEO's scope to conduct energy audits, thereby broadening participation beyond the regulated stock.[36]

ALIGNMENT AND REMAINING GAPS

The BEEAO marked an important strengthening of Hong Kong's regulatory foundation. By expanding coverage, shortening audit intervals to five years, and mandating disclosure of technical information, the law now provides stronger drivers for retrofit action.

Yet two critical gaps remain:

- Integration of PBC into compliance strategies: PBC is not yet endorsed as a pathway to compliance, even though PBC could help owners manage capex and performance risk.

- Lack of financial mechanisms: Complementary incentives or finance structures have yet to be proposed, without which, regulatory obligations risk becoming a box-ticking exercise rather than a trigger for scaled investment.

EXTENDING DISCLOSURE TO FINANCIAL RISK ASSESSMENT

Beyond energy audits, stakeholders have suggested that Hong Kong could strengthen the link between building performance and financial risk management. One option would be to introduce mandatory physical climate risk assessments, covering hazards such as flooding, extreme heat, and storm damage, for disclosure to lenders and insurers. This would align building-level disclosure with the financial sector's growing need to quantify exposure to physical risks. In parallel, PBC-linked indicators could be developed for building insurance products, rewarding verified efficiency improvements with more favourable terms. Such measures would create a more direct feedback loop between retrofit action, risk reduction, and financing costs, complementing the strengthened but still limited disclosure regime under the BEEAO.

Taken together, these ideas highlight that while better disclosure can align risks across regulators, financiers, and insurers, disclosure alone is insufficient to drive large-scale retrofits. Regulation on its own rarely delivers transformation. Compliance-driven retrofits tend to produce only incremental gains unless they are paired with robust financing and delivery models. PBC is a critical complement because it aligns repayment with verified outcomes and reduces the potential for disputes. When such alignment is present, regulatory requirements can act as a genuine catalyst for investment, giving owners, contractors, and financiers the confidence that risks are shared transparently and results will be sustained.

CONCLUSION

The BEEAO represents significant progress in strengthening Hong Kong's building energy regime. It broadens coverage, accelerates the audit cycle, and improves transparency. Early evidence also shows that audits can deliver real energy savings (see Chapter 1). However, regulation alone cannot deliver scale. The challenge ahead is to ensure that these stronger obligations are matched by financing pathways and innovative compliance models, such as PBC and its variants. Only by linking regulation, finance, and market practice can retrofitting shift from being a compliance duty to becoming a transformative strategy for decarbonisation.

29. The Chief Executive's Policy Address 2023, https://www.policyaddress.gov.hk/2023/en/.
30. Electrical and Mechanical Services Department (2023). *Public Consultation on the Enhancement of the Buildings Energy Efficiency Ordinance*. https://www.emsd.gov.hk/beeo/en/pee/BEEO_consult_2023_eng.pdf.
31. Energy Utilization Index (EUI) is used to indicate the energy consumption level and energy use intensity of different operating entities. For buildings, it is It is calculated by dividing the total energy consumption of a building by its total floor area.
32. Although the BEC and EAC are codes of practice and not primary legislation, they are issued under the BEEO, which means in practice building owners and professionals must follow the codes, while their regular updates allow technical standards to keep pace with advances in efficiency.
33. Some stakeholders had advocated a three-year cycle during the consultation, but industry groups strongly opposed such a move.
34. The Register of Registered Energy Assessors (REAs) is available online via EMSD's website and is part of the BEEO regulatory system to show assessors who have the relevant technical experience.
35. Environment and Ecology Bureau, & Electrical and Mechanical Services Department. (2025, March). *Buildings Energy Efficiency (Amendment) Bill 2025: Legislative Council Brief* (File Ref.: EEB 24/26/22 Pt. 44). Hong Kong SAR Government, and Legislative Council Secretariat. (2025, June 6). *Report of the Bills Committee on Buildings Energy Efficiency* (Amendment) Bill 2025 (LC Paper No. CB(2)1149/2025). Hong Kong SAR Legislative Council.
36. Legislative Council Secretariat. (2025, July 28). *Background brief on energy saving measures in buildings* (LC Paper No. CB(1)1214/2025(05)). Hong Kong SAR Legislative Council.

CHAPTER 4

SCALING AND FINANCING WHAT WORKS: PBC IN MANY FORMS

Financing is the critical enabler for scaling the retrofitting of existing buildings. While the preceding chapter shows that Hong Kong now has a stronger regulatory foundation for energy upgrades through the BEEAO, Chapters 1 and 2 also make clear that regulation alone cannot unlock retrofit demand at the scale required. The principal constraint remains the lack of accessible, affordable, and appropriately structured financing.

Financing is not simply a technical add-on to retrofit policy; it determines whether building owners proceed with upgrades. Without viable funding models, even well-designed regulations risk producing compliance in form rather than in substance, yielding minimal or incremental improvements instead of deep, performance-based retrofits. To succeed, financing models must be trusted. For retrofits, this requires contracts that allocate risks transparently, verify outcomes reliably, and minimise post-project disputes. In this sense, PBC is not merely a delivery mechanism but the foundation of bankable finance.

This chapter reviews the CEPU Report and the 2025 HKGFA White Paper to assess their financing proposals, identify common ground, introduces variants of PBC, and develop a possible financing roadmap for Hong Kong.

CEPU REPORT – FINANCING IN A POLICY AND INSTITUTIONAL CONTEXT

The CEPU Report approached financing as an inseparable component of the retrofit policy framework. Its key insight is that financial mechanisms must be designed and launched in tandem with regulatory measures, not after the fact. For EPC specifically, the report identifies three categories of financial enablers:

(a) Risk-Sharing Facilities and Guarantees

- Establish a public-private risk-sharing facility to underwrite a portion of the performance risk in EPC contracts, giving commercial banks the confidence to lend against anticipated energy savings.
- Use partial credit guarantees to reduce the capital cost of borrowing for building owners and ESCOs.

(b) Targeted Incentives

- Tax deductions or accelerated depreciation allowances for energy-efficient equipment.
- Direct subsidies for early adopters of EPC in the public and commercial sectors, especially in multi-owner or strata-title buildings where decision-making and cost-sharing are complex.

(c) Leveraging Existing Financial Markets

- Promote green bonds and sustainability-linked loans tailored for retrofit projects, with eligibility linked to verified M&V results.
- Partner with insurers to create performance insurance products that protect lenders and owners from underperformance.

The CEPU Report also emphasises public sector leadership: launching government-led EPC pilots in hospitals, schools, and public housing to create a reliable project pipeline and demonstrate bankable case studies. These pilots would serve both as proof-of-concept for private investors and as a training ground for local ESCOs and financial institutions.

HKGFA WHITE PAPER – FINANCING FROM A MARKET MOBILISATION PERSPECTIVE

The HKGFA White Paper identified the lack of scalable financing channels as a constraint and sets out three strategic "asks" to unlock retrofits. Firstly, the paper called for a dedicated buildings decarbonisation plan, providing long-term policy clarity to mobilise capital and align stakeholder expectations. Second, it highlighted the need for a systemic and granular disclosure regime for building energy use, covering audits, benchmarks, and mandatory actions for underperformers, and thirdly, it stressed that the public sector must play a proactive financial role by offering guarantees, concessional loans, and catalytic funds, especially to lower barriers for SMEs and to enable demand aggregation.

Alongside these headline asks, the HKGFA White Paper reviewed a spectrum of financial mechanisms. It pointed EPC and Energy Service Agreements (ESA) as performance-based models that shift risk away from building owners and make retrofit projects more bankable. It also referenced on-bill finance, Property Assessed Clean Energy (PACE), revolving funds, green mortgages, and sustainable bonds as examples of tools already tested in other markets.

Taken together, HKGFA's recommendations focussed on establishing an enabling ecosystem: predictable policy, robust data, and public-private risk sharing. Within such a framework, market actors can further innovate financing products, including service-based and performance-linked structures to meet the needs of diverse building owners.

The HKGFA White Paper also underscored that Hong Kong's comparative advantage lies in its role as an international green finance hub. Its recommendations therefore emphasised the importance of mobilising private capital by making retrofit projects more "investor-ready" and by aligning financing approaches with recognised Environmental, Social and Governance (ESG) and green finance standards.

The HKGFA also underscored the importance of transparency and comparability in energy data. Its White Paper called for enhancing the disclosure regime under the BEEO and expanding it to whole-building energy use, so that performance can be benchmarked more meaningfully. Such data improvements would also strengthen financing due diligence by giving lenders and investors a clearer basis for assessing retrofit opportunities.

PBC: EPC AND ITS VARIANTS

International practice shows that EPC should not be viewed in isolation but as part of a broader family of performance-based service models. Variants such as ESAs, Energy-as-a-Service (EaaS), and Build-Own-Operate-Transfer (BOOT) arrangements share a common objective: reducing upfront costs for building owners while aligning repayment with performance outcomes.

In Hong Kong, these arrangements are being gradually adopted, such as enabling building owners to host renewable generation (solar systems) without capital outlay, while long-term Cooling-as-a-Service (CaaS) agreements (a type of EaaS) show how subscription-based cooling can deliver zero-carbon systems. These cases underscore that the principle of PBC – risk and cost recovery tied to performance – can be adapted into multiple contractual forms depending on the asset type and owner preference. Owners with different constraints can choose from variants that suit their appetite for risk, contract length, and operational involvement. Positioning EPC and variants within this wider family of as-a-service solutions strengthens the case for government support, standardised contracts, and demonstration projects. It also reinforces that Hong Kong has multiple pathways to mainstream retrofits through models that align incentives and reduce capital barriers.

BOX 2
PBC/EPC Variants

Energy-as-a-Service (EaaS)
EaaS is a subscription-based business model where customers pay for an energy service (e.g. cooling, lighting, or adding renewable energy) rather than for the equipment itself. The service provider owns, installs, operates, and maintains the infrastructure, recovering costs through periodic service fees. EaaS lowers upfront capital barriers for building owners, while providing service providers with predictable revenue streams with performance guarantee.

Build-Own-Operate-Transfer (BOOT)
BOOT is a project delivery model in which the service provider finances, designs, builds, owns, and operates an energy system for an agreed period. Costs are recovered through service payments during this term. At the end of the contract, ownership of the asset is transferred to the customer. BOOT arrangements are common in long-life energy system such as chiller plants and district cooling systems, where service providers can spread investment risk over 15–20 years while delivering guaranteed performance.

BOX 3
Retrofit-as-a-Service (RAAS+) by Next-Generation ESCOs

A new frontier in PBC is the idea of what may be called Retrofit-as-a-Service (RAAS+), which extends beyond traditional arrangements. Under this new idea of RAAS+, building owners enter long-term service agreements, potentially spanning 20 years or more that combine multiple functions into a single, integrated offering.

Rather than focusing narrowly on equipment installation, RAAS+ would package equipment leasing, ongoing maintenance, software and product/equipment upgrades, PBC delivery, and continuous performance monitoring into one recurring service fee. This model provides building owners with predictable outlays, while enabling service providers to generate stable, annuity-like revenue streams.

The industrial logic for RAAS+ is compelling. Equipment vendors with leasing and maintenance expertise could partner with facility management companies that already manage long-term client relationships, creating 'next-generation ESCOs'. Alternatively, corporate carve-outs or new platforms could emerge, backed by investors seeking stable cash flows and growth from green services. Similar business model innovation is visible in Hong Kong's energy sector: for example, Towngas Smart Energy Company Limited has expanded from city gas supply into solar and energy services with long-term contractual revenues in Mainland China.

From a finance perspective, RAAS+ makes retrofits more investor-friendly by reducing volatility and aggregating services into a predictable yield profile. By positioning retrofits as an ongoing service rather than a one-off project, RAAS+ could attract new sources of private equity and institutional capital into the retrofit market.

CONVERGENCE AND DIVERGENCE

There is a high degree of convergence between the CEPU Report and the HKGFA White Paper. They converge as:

- Both identified EPC as a critical delivery model for deep retrofits and see financing as essential to its uptake.
- Both stressed the importance of de-risking mechanisms (guarantees, insurance, blended finance) to attract capital.
- Both call for robust M&V frameworks as the foundation for financing agreements.

Where they diverged was that while the CEPU Report focused on policy integration, public sector leadership, and aligning financing with regulatory obligations, the HKGFA White Paper focused on market mobilisation, global investor alignment, and leveraging Hong Kong's status as a finance centre to attract international capital. The White Paper also introduced ESAs alongside EPC, while the CEPU Report focused on EPC.

Taken together, both reports outlined a dual-track strategy for financing building retrofits in Hong Kong:

- The CEPU Report's *Policy-Integrated Financing* track embeds financing mechanisms into BEEAO obligations, so building owners have access to capital when compliance triggers retrofits, supported by public-private risk-sharing facilities and EPC pilots in public buildings to build lender confidence.
- The HKGFA's *Market-Mobilisation Financing* track positions retrofits as a flagship green finance asset class, with internationally aligned taxonomies and transparent performance data, leveraging Hong Kong's green finance capabilities to mobilise international institutional investors into the local retrofit market.

THE DATA-FINANCE LINK

One of the most important prerequisites for unlocking finance is the availability of reliable data. Banks and investors require credible baselines, standardised metrics, and transparent verification to underwrite loans or structure investment products. In Hong Kong, energy audit data collected under the BEEO provides a potentially rich dataset for this purpose, but until recently, disclosure restrictions made it difficult to use. The BEEAO has created a breakthrough – going forward, building

BOX 4
HKMA Sustainable Finance Action Agenda

HKMA has set out its *Sustainable Finance Action Agenda* in 2024 that strengthens the alignment between the financial sector and net-zero goals:[37]

- Transition Plans – All banks should strive to achieve net zero in their own operations by 2030 and in financed emissions by 2050. From 2030, banks must submit Paris-aligned transition plans to HKMA on a "comply or explain" basis.
- Disclosure Standards – Banks are expected to align with international sustainability frameworks for climate risk and sustainability disclosure.
- Mobilising Capital – Target to have at least one-third of bonds issued in Hong Kong being sustainable. Digital green bonds and other fintech innovations will be promoted.
- Responsible Investment – The Exchange Fund aims for net zero by 2050 in its investment portfolio, actively expanding investments into ESG and climate-transition assets across public and private markets.

Relevance to Retrofitting and EPC

These priorities reinforce the case for treating retrofits as a *mainstream asset class* for banks and investors. Retrofitting directly supports banks' decarbonisation targets, provides measurable outcomes for disclosure, and represents a scalable investment theme within Hong Kong's green finance platform. Integrating retrofit loans and PBC-linked financing into transition plans would help local banks meet HKMA's expectations while mobilising capital into one of Hong Kong's largest sources of emissions reduction.

owners are now required to submit a Data Disclosure Form after carrying out energy audits in 5-year cycles as discussed in Chapter 3, and EMSD must publish the information on a publicly accessible website. This change resolves the longstanding legal obstacle of making audit data available to parties other than the data owner, opening the way for better market transparency. EMSD has encouraged stakeholders to focus on making good use of this data once it becomes available.

CDI AS A COMPLEMENTARY CHANNEL

There is the potential role for the Hong Kong Monetary Authority's (HKMA) Commercial Data Interchange (CDI). CDI is a consent-based digital infrastructure that allows banks to access verified data from government and corporate sources for credit assessment. CDI's linkage with the HKSAR Government's Consented Data Exchange Gateway has made it possible for government data source to be connected to CDI, with Companies Registry being the first example. By having EMSD's audit database connected to CDI via this established channel, banks can better access energy audit data to facilitate their assessment of building owners' retrofit loan applications or sustainability-linked borrowing.[38]

Bankers note that the platform model could mirror the personal credit bureau: as building owners have to report their audit periodically (every 5 years under the BEEAO and that information is released), a convenient platform is needed for the data to be shared with banks when owners seek retrofit loans or green finance. In addition, banks could purchase aggregate datasets to size markets and design new products. The main caveat is that currently CDI's data owners are primarily SMEs and users are authorised institutions (banks), but there is room to extend to other stakeholders such as commercial building owners applying for retrofit loans or sustainability-linked borrowing, ESCOs and non-bank institutional investors in the future.

Both the CEPU Report and the HKGFA White Paper stressed that finance is the missing link in Hong Kong's retrofit market, though they approached the issue from different angles. The CEPU Report emphasised embedding financing mechanisms within regulatory obligations, supported by public sector pilots and guarantees, while HKGFA highlighted the need to mobilise international capital through transparency, standardisation, and investor-ready products. Together, these perspectives point towards the same conclusion: Hong Kong requires a financing architecture that is both policy-anchored and market-facing.

TOWARDS A RETROFIT FINANCE PLATFORM

The BEEAO, the release of audit data on an EMSD website, and the potential use of HKMA's CDI point to a new opportunity: Hong Kong could establish a *Retrofit Finance Platform* that integrates public disclosure, consent-based data sharing, and financial product innovation.

Such a platform would operate on three levels:

1. Public disclosure (EMSD): The BEEAO ensures that basic building audit data is publicly available, creating transparency and accountability. This provides the foundation for market benchmarking and public policy design.

2. Consent-based access (CDI): For loan origination, CDI can give banks structured, verified, and standardised access to audit data already released by EMSD, reducing transaction costs and information asymmetry.

3. Aggregate analytics (finance sector): With aggregated datasets, banks can size opportunities, develop SME-focused loan products, and design sustainability-linked financing tied to performance outcomes.

It should be possible for HKMA to work with EMSD and banks to refine data use protocols and to align them with retrofit financing models. Over time, this integration would allow retrofit projects to be presented as investor-ready assets, supported by transparent data, credible benchmarks, and performance-linked finance.

COMPLEMENTARITY WITH GLOBAL FINANCE INITIATIVES

This architecture also fits with Hong Kong's ambition to strengthen its position as a global green finance hub. By linking energy audit data to CDI and embedding it in the *Retrofit Finance Platform*, Hong Kong would create a unique mechanism for data-driven climate finance, comparable to the way credit bureaus underpinned consumer lending. Such an approach could attract international institutional investors seeking transparency and scale in Asia's built environment.

ADDRESSING THE NEEDS OF SMALLER ASSET OWNERS

While large commercial buildings are often the focus of retrofit financing discussions, a substantial share of Hong Kong's building stock is held by smaller asset owners, including strata-title commercial and residential blocks, and older mixed-use buildings. These owners face a distinct set of barriers that must be addressed if retrofit financing is to achieve systemic impact.

First, smaller owners generally have limited access to affordable finance. Banks are often reluctant to extend loans for modestly sized retrofit projects, especially when collateral is weak or when anticipated savings appear too small to justify the administrative burden. Second, in multi-owner buildings, reaching consensus on retrofit investments can be slow and contentious, with individual owners often reluctant to bear upfront costs. Third, the transaction costs of structuring performance contracts or accessing specialist financing are disproportionately high relative to project size, making it uneconomical for ESCOs or lenders to engage without aggregation.

These challenges point to the importance of aggregation mechanisms and simplified financing models. A platform-based approach, as outlined earlier, could play a catalytic role by pooling smaller projects, standardising contracts, and using audit data to give financiers confidence in projected savings. Cooperative models, where groups of SMEs or owners' corporations bundle demand for retrofit services, could also reduce costs and strengthen bargaining power. Public support, whether through concessional finance, technical assistance, or guarantees, may be essential to bring these smaller actors into the retrofit market.

LEVERAGING HONG KONG'S SME FINANCING GUARANTEE SCHEME

One immediate opportunity would be to adapt the Government's existing SME Financing Guarantee Scheme to support energy-saving retrofits. By providing enhanced guarantees for loans tied to verified energy performance improvements, the scheme could reduce perceived credit risk and open financing channels for smaller ESCOs and mid-tier building owners. Linking eligibility to demonstrated or certified energy savings would further strengthen the integrity of the mechanism, ensuring that public risk-sharing translates directly into measurable efficiency gains. This would align Hong Kong's support framework with international precedents while directly addressing the financing barriers faced by SME-ESCOs.

LEVERAGING THE PUBLIC SECTOR AS A MARKET CATALYST

Alongside addressing the needs of smaller asset owners, the public sector can play a decisive catalytic role in accelerating retrofit adoption. The HKSAR Government controls a substantial portfolio of assets, including government offices, schools, hospitals, public housing estates and many other public buildings and infrastructure that collectively represent a significant share of Hong Kong's built environment. Unlike private owners, government entities face fewer barriers in accessing capital and can absorb longer payback periods, giving them a unique ability to act as a substantial first movers in the retrofit market.

By applying PBC models across its building stock, the HKSAR Government could reduce its own energy use and demonstrate performance-based contracting. Public buildings and government facilities can serve as testbeds for standardised contracts, localised M&V protocols, and transparent reporting, all of which are essential to building market confidence. Once these practices are institutionalised, they can be transferred into the private sector, lowering transaction costs and reducing perceived risks for investors and building owners.

In this sense, public sector retrofits are not just about achieving savings in government facilities, but about kick-starting a retrofit market in Hong Kong. Acting as a large, credible client, the HKSAR Government could create the demand signals necessary to attract ESCOs, financiers, and service providers from all around the world laying the groundwork for a pipeline of private sector projects to follow.

BOX 5
Concern of SME-ESCOs

Small- and medium-sized Energy Service Companies (SME-ESCOs) often face greater challenges than large international players in delivering retrofit projects. While large ESCOs may use their own balance sheets to finance several projects concurrently, smaller firms lack the same capacity. Their ability to scale is constrained by difficulties accessing affordable credit and by investor doubts over whether they can guarantee long-term savings. Without support, this imbalance risks leaving SMEs, who often have strong technical expertise and local presence, sidelined from the retrofit market.

International experience shows how government-backed programmes can help address these barriers. In Germany, KfW's energy efficiency programmes reduce financing risks by combining long-term, low-interest loans with grants, while mandatory energy consultant involvement ensures quality.[39] This structure lowers transaction risk and builds lender confidence, creating space for SMEs to compete alongside larger firms.

In Estonia, the KredEx revolving fund provides housing associations with preferential loans and grants while offering guarantees that cover part of the credit risk.[40] By backstopping loans, KredEx has enabled smaller ESCOs and contractors to secure projects that would otherwise be inaccessible.

The lesson for Hong Kong is that publicly backed guarantee schemes or revolving funds can play a catalytic role. By absorbing part of the risk, governments can enable SME-ESCOs to participate in the retrofit market on a level playing field, ensuring diversity of service providers and accelerating market growth. Hong Kong's existing SME Financing Guarantee Scheme[41] already demonstrates the principle, offering 80%–90% guarantees on credit facilities to help small businesses secure finance. A retrofit-specific guarantee mechanism, embedded within this framework, could similarly unlock capital for SME-ESCO-led PBCs and broaden participation in the market.

CONCLUSION

Taken together, the CEPU Report and the HKGFA White Paper outlined complementary pathways for financing Hong Kong's retrofit transition: one emphasising policy and regulatory scaffolding, the other highlighting market mobilisation and international capital flows. The BEEAO and the new disclosure of audit data provide the missing transparency, while CDI potentially offers a mechanism to integrate that data directly into bank lending processes – the mechanics and details having to be worked out. Together, these elements point to the foundations of a *Retrofit Finance Platform* that can align regulatory requirements, verified performance data, and investor confidence within a single financing ecosystem.

Systemic reform must not overlook the realities of smaller asset owners, as well as smaller ESCOs, who face distinct barriers to accessing finance and whose participation is essential if retrofitting is to scale across Hong Kong's diverse building stock. Here, revolving public sector guarantees, aggregation mechanisms, cooperative models, and simplified lending products will be vital. At the same time, the public sector has an unparalleled opportunity to act as a catalyst, using its extensive building portfolio to pioneer performance-based retrofits, set standards, and demonstrate transparent, bankable models for the private market.

The task ahead is therefore not only to mobilise capital, but to ensure it flows into a balanced ecosystem in which large commercial assets, smaller private owners, ESCOs, and public sector buildings each play their role. By embedding retrofit financing in both regulatory and market frameworks, Hong Kong can create the scale, trust, and momentum needed to transform retrofitting from a fragmented activity into a cornerstone of its climate strategy and position itself as a global leader in green finance for the built environment. The central lesson is that finance and contract design are inseparable: only when risk-sharing and outcome verification are clearly defined will retrofit financing flow at the speed and scale required.

36. The EU Taxonomy for sustainable activities and the Climate Bonds Standard for buildings establish internationally recognised thresholds for defining retrofit and renovation projects as environmentally sustainable, emphasising minimum energy performance, measurable efficiency improvements, and life-cycle carbon reductions. Aligning Hong Kong's regulatory and financing measures with such standards would enhance credibility and comparability for global investors.
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DEMONSTRATING THE ECONOMICS OF RETROFITTING

So far, this paper has explored the alignment needed between regulation and finance for a more active retrofit market to be created in Hong Kong. But to convert this potential into real investment, stakeholders require credible signals on costs, returns, and technical feasibility. Building owners, investors, banks, and government actors must understand how retrofitting performs not just in theory, but in practice, whether for large property portfolios that can influence broader market momentum, or for smaller-scale owners operating with tighter constraints.

THE ECONOMICS OF RETROFIT: EVIDENCE FROM SCENARIOS

The economic case for retrofitting buildings in Hong Kong is already clear. As already discussed in previous chapters, retrofitting Hong Kong's building stock offers one of the most direct and effective pathways to reducing electricity consumption and carbon emissions. Decades of technical research, combined with multiple demonstration projects, show that energy-saving retrofits are neither exotic nor speculative. They rely on well-established measures, such as upgrading HVAC systems, replacing inefficient lighting, and improving building management systems for quick returns. Other common measures include lift modernization and changing the façade, although the payback periods are longer.

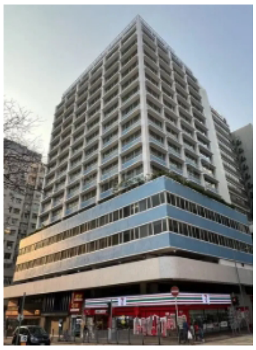
The following case study of KINS Engineering demonstrates how well-established retrofit measures work in practice, and there is the possibility to combine energy savings with improvements in IAQ across different building types.

CASE 1: KINS ENGINEERING – ENERGY SAVINGS AND INDOOR HEALTH ACROSS DIVERSE BUILDING TYPES

HKUST has worked with KINS Engineering for several years to understand the company's proprietary Fresh Air Unit (FAU) systems because of their exceptional results. The FAU integrates energy recovery ventilation, humidity control, multi-stage filtration, and smart monitoring into a compact, low-disruption system. It has been applied across diverse retrofit contexts in Hong Kong, consistently delivering substantial energy savings alongside improved IAQ.

In a city grappling with high humidity, outdoor air pollution, and dense occupancy, the KINS FAU model shows how retrofits can simultaneously enhance building performance and public health. HKUST's technical team has measured results from multiple KINS projects, confirming both energy and IAQ benefits. Table 2 provides the data to show attractive pay back periods.

Example A: TAL Building



The TAL Building (16-storey, built in 1975) underwent a major HVAC retrofit using KINS FAU a decade ago. Annual electricity was reduced by 670,000 kWh, a 51% reduction worth HK$780,000 per year. With a retrofit cost of HK$2.4 million, the payback was around 3 years. Importantly, thermal comfort and IAQ were maintained, showing that efficiency gains need not compromise occupant well-being.

A separate published study documented TAL's retrofit, noting the transition from outdated constant air volume units to a variable air volume system with demand-controlled ventilation using CO_2 sensors. Control logic was also optimized, enhancing responsiveness to occupancy. These changes reduced HVAC energy use by 51% while maintaining CO_2 and $PM_{2.5}$ levels within acceptable thresholds.[42] Thermal comfort remained predominantly within the ASHRAE comfort zone,[43] demonstrating that energy efficiency and occupant satisfaction can coexist when advanced controls and sensors are properly deployed.

The TAL case demonstrates the high return potential of smart, control-based HVAC retrofits in Hong Kong's office sector. The ability to achieve substantial energy savings without full system replacement illustrates the high return potential of well-engineered control-based retrofits. Strategically, this case highlights the value of targeted HVAC improvements in Hong Kong's commercial sector. It reinforces the finding from earlier examples that meaningful energy and cost savings are achievable when building owners invest in smart, performance-oriented upgrades, particularly those involving ventilation and indoor climate control technologies.

Example B: Jao Tsung-I Academy (Heritage Building)

At the Jao Tsung-I Academy, a heritage complex completed in 2024, uncontrolled humidity threatened wooden structures and artefacts. A KINS FAU retrofit created a stable dried airflow regime, protecting cultural assets without damaging the building's historic fabric. By avoiding mold and repair costs, the retrofit delivered both financial and preservation value, showing that heritage buildings can also benefit from precision climate control.

Example C: Lee Woo Sing College Canteen (The Chinese University of Hong Kong)

The retrofit project at the Chinese University of Hong Kong's Lee Woo Sing College canteen serves as an exemplary case study for Hong Kong's decarbonization goals. The retrofit involved a mixed mode application of a FAU with the existing air-conditioning system and air handling units.

This approach demonstrates a highly replicable engineering strategy: by centralizing the dehumidification, pre-cooling, air filtering and ventilation process to one FAU, the existing air-conditioning system can be served as a personalized ventilation system and work at its minimal, only provide personalized cooling. This integration maximizes the efficiency of the incumbent system without requiring the removal of existing facilities.

The result was a 30% reduction in annual electricity consumption, from 235,000 kWh/year to 156,000 kWh/year (actual saving 78,928 kWh), with payback period of about 3 year.

The success of mixed mode application makes the solution ideal for retrofitting Hong Kong's vast inventory of existing commercial, institutional, and residential buildings. The technology leverages existing air-conditioning assets, minimizes structural intervention, and delivers immediate improvements in energy efficiency, operational cost, and indoor environmental quality.

TABLE 2: PROJECTS SUMMARY OF KIN ENGINEERING'S PROJECTS

Project	Building Age	Retrofitting Work	Energy Saving	Particulate Matter (PM) Removal Efficiency	Dehumidification Efficiency	Retrofit Cost	Payback Period
TAL Building	50 years (since 1975)	Fresh Air Unit (FAU)	51%	60% - 90%	[vi]	HK$2,400,000	3.3 years
Jiao Tsung I Academy (Block Q)	138 years (since 1887)[i]	Fresh Air Unit[ii] (FAU)	29%	16% - 20%[v]	25%[iv]	HK$108,600	2 years
Chinese University of Hong Kong (canteen)	12 years (since 2012)	Fresh Air Unit (FAU)	30%	N/A[iii]	20%	HK$700,000	3 years

Notes:
i. Primitive window type air-conditioners installed at offices of psychiatric hospital in 1975. Modern HVAC system installed since 2012.
ii. Retrofitting work mainly focuses on dehumidification. Energy saving and payback period are rough estimates in the absence of energy measurement before retrofitting work.
iii. Only CO_2 measured at the concern of users.
vi. Significant improvement reported by asset owner without comprehensive documentation.
v. The observed low efficiency primarily due to very low outdoor $PM_{2.5}$ concentrations (around 5 μg/m^3 outdoor $PM_{2.5}$ concentration during the measurement period). All indoor PM_{10} & $PM_{2.5}$ concentrations remained within both the Hong Kong Indoor Air Quality Objectives (HKIAQO) and WHO Air Quality Guidelines (AQG) limits.
iv. Indoor relative humidity maintained below 65%.

Summary of KINS Results

Across all deployments, KINS FAU systems consistently reduced energy demand while improving IAQ. Indoor PM_{10} and $PM_{2.5}$ were reduced by up to over 60% compared to outdoor levels, while other pollutants remained well below World Health Organization's Global Air Quality Guidelines.[44] In humid environments, FAU also prevented mold, reducing sick-building risks.

These results underline the strategic value of integrated retrofits: energy savings, operational resilience, and public health improvements achieved together. Data-driven controls allow optimisation by season and occupancy, while compact system design enables deployment in diverse building types, from commercial offices to heritage sites to educational facilities.[45] EPC can certainly take IAQ improvements into account by better understanding how the co-benefit of better IAQ and human health can go together.

BOX 6
Productivity Gains from Better Indoor Air Quality

Research has shown links between better ventilation and improvement in cognitive performance, which in Hong Kong's knowledge-based economy could translate into substantial economic gains. Yet, such benefits are not reflected in current financing or policy frameworks, reinforcing a narrow focus on electricity bills as the sole metric of value:

- World Green Building Council (2014): Synthesizing global studies, the council reported that better ventilation and IAQ are associated with 8%–11% gains in workplace productivity.[46]
- Harvard T.H. Chan School of Public Health: In a controlled study of office environments, cognitive function scores were 61% higher in "green" buildings and 101% higher in "enhanced green" buildings compared to conventional offices.[47]
- Fisk (2000): A review of indoor environment studies estimated 1%–10% improvements in work performance from reduced sick building symptoms and cleaner air.[48]

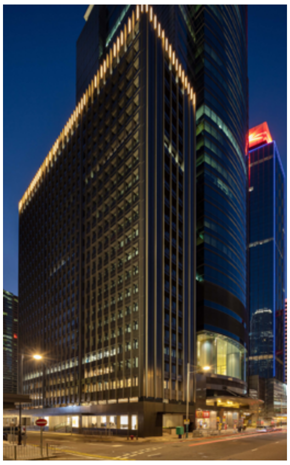
Taken together, these findings support the widely cited figure of a ~10% productivity benefit from cleaner indoor environments, an important, though often overlooked, co-benefit of building retrofits.

BOX 7
Indoor Air Quality as a Co-Benefit Worth Incentivizing

IAQ should not be seen only as a private benefit for individual buildings but as a broader societal gain. To make this policy dimension explicit, the reasons below set out why IAQ improvements deserve recognition as a co-benefit of retrofits, whether the PBC method is used or not:

- **Public Health Benefit:** Improved IAQ is not only a private advantage for building owners but also a public good. If many buildings adopt IAQ-enhancing retrofits as a part of its energy saving effort, the wider population enjoys better health outcomes, reduced sick days, and stronger cognitive performance.
- **Policy Implication:** Because IAQ improvements yield public benefits, they provide a strong rationale for government incentives. Building owners who can demonstrate measurable IAQ gains (which can be done through using real-time monitoring) could qualify for some public incentives.
- **Financing Implication:** For banks and investors, IAQ enhances ESG outcomes:
  - **E (Environmental)**: lower energy use and emissions.
  - **S (Social):** healthier occupants and workforce productivity gains.
- **Verification:** Real-time IAQ measurement makes it possible to quantify and certify these health-related benefits, strengthening their role in both policy frameworks and financial decision-making.

CASE 2: SINGLE BUILDING OWNER RETROFIT USING EPC



The owner operates the 20-storey building – The Sun House – originally completed in 1977 that functioned as an office tower with retail shops on the ground level. Over time, the building's attractiveness decreased due to its deteriorating aesthetic appeal and outdated spatial arrangement and style. The owner revitalized the building to compete in today's rental market from 2016 for about three years. In this case, changing the façade made sense although at considerable expense because the decision was justified not only by aesthetic renewal but also by performance gains that offset the initial expense. The lobby was transformed from a basement lobby to a grand entrance elevated on the ground level, which became also a showcase of co-working spaces.

The building relies on a 360-ton air conditioning system that consumed approximately 1 million kWh of electricity annually with an associated cost of about HK$1.9 million prior to the owner entering a performance-based EPC with an ESCO to save energy. As the building had already been upgraded several years ago, the EPC focused on optimizing existing systems and changing operational behaviours. Measures included installing a web-based energy monitoring system, applying analytics to detect inefficiencies, engaging users to adopt energy-saving practices, and implementing a continuous improvement cycle. No major equipment was replaced, making this a non-intrusive and scalable model. The results were compelling. Annual electricity savings reached 100,000 kWh, translating into financial savings of around HK$190,000. Under the EPC arrangement, the savings were shared: 55,000 kWh per year (equivalent to HK$1 million over 10 years) went to the ESCO, while the building owner retained savings of 45,000 kWh per year (around HK$800,000 over 10 years). An additional 5% reduction in energy use is expected through ongoing operational tuning. The total monitoring fee over the contract period was HK$360,000.

This case illustrates the power of low-capex, digital-first retrofits. Even without replacing physical infrastructure as it was relatively new, the building achieved measurable energy and cost savings. The EPC model allowed the owner to avoid technical risk while improving performance and gaining familiarity with energy management practices. Such approaches are especially suited to SMEs or buildings with fragmented ownership where traditional capital-intensive retrofits are difficult to execute.

Strategically, the owner's experience demonstrated how Tier 1 interventions can serve as an entry point into a broader retrofit strategy even for a recently upgraded building. By starting with behaviour-focused, monitored improvements, owners can establish a performance baseline, capture early savings, and lay the groundwork for deeper retrofits in future project cycles.

BOX 8
Retrofit Tiers Explained

Retrofit measures can be grouped into three broad tiers of interventions reflecting the extent of capital expenditure and level of building system upgrades involved.

- **Tier 1 Light retrofits** typically include low-cost measures such as repainting frames, replacing seals or gaskets, upgrading lighting controls, or installing more efficient appliances.
- **Tier 2 Medium retrofits** go further, addressing building envelope and services components such as improving insulation, replacing spandrel or cladding panels, upgrading HVAC systems, or in-situ replacement of vision glass.
- **Tier 3 Deep retrofits** involve comprehensive upgrades to multiple systems, such as full envelope replacement, major HVAC redesign, or structural adaptations that significantly enhance building performance and resilience.

Each tier can deliver meaningful improvements, and combinations of measures are often applied in practice.

BOX 9
Understanding Payback Periods in Building Retrofits

Payback period is one of the most widely cited metrics for retrofit projects, but its meaning varies depending on the assumptions used. At its simplest, payback refers to the time needed for cumulative cost savings to equal the initial investment. In practice, however, owners and investors often include a broader set of outcomes, which makes direct comparisons between projects difficult.

Key dimensions that may be included in "payback" are:

- Direct energy savings – reductions in electricity bills from more efficient equipment.
- Operational savings – lower maintenance and repair costs from newer systems.
- Revenue-side benefits – uplift in rental yields, occupancy, or tenant mix.
- Asset value gains – increased building valuation or share price.
- Insurance effects – reduced property insurance premiums where climate resilience is demonstrated to improve.
- Occupant and tenant satisfaction – better comfort, indoor air quality, or building aesthetics that improve market competitiveness.

Because different stakeholders use different definitions, reported payback periods should be treated as indicative rather than strictly comparable. For a fuller picture of costs and benefits, financial metrics such as Net Present Value (NPV) or Internal Rate of Return (IRR) may provide a more robust basis for decision-making.

CONCLUSION

The case studies presented in this chapter reflect the diversity of Hong Kong's building stock and the range of motivations driving owners and institutions to improve energy performance. They reveal both the technical and financial feasibility of retrofitting, as well as the diversity of responses from lighter retrofits.

Both KINS and Sun House show that lower tier retrofits can deliver strong returns with paybacks under 3-4 years, while also enhancing IAQ and occupant comfort (although IAQ is seldom considered with retrofit, but it should be as a co-benefit). Lower tier measures remain the easiest entry point, while Tier 3 measures demand more sophisticated financing structures. Public buildings, educational institutions, and heritage sites feature prominently in this landscape, demonstrating how retrofits can align with civic and institutional goals such as education, cultural preservation, and community health, while still yielding cost and energy savings. The range of delivery models reflects the growing complexity and maturity of the retrofit market.

A key insight is that there is no one-size-fits-all approach. Lower tier projects, with their high return-on-investment potential, should be prioritised, but lower-performing assets also need pathways for action, whether through aggregated financing, blended capital, or phased upgrades. The cases also illustrate a consistent and encouraging pattern: when retrofits are undertaken, they generate measurable energy savings with payback periods well within the investment horizons of most building owners. For long-term asset holders, such as developers, institutional investors, and portfolio managers, these returns should be compelling.

Beyond direct cost savings, retrofits yield important co-benefits: improved IAQ, enhanced occupant comfort, and greater tenant satisfaction. These factors reinforce asset value, rental competitiveness, and workforce productivity. When aggregated across many buildings, IAQ improvements also contribute to better population health outcomes thereby strengthening the rationale for government incentives and creating measurable "S" alongside the "E" in ESG reporting.

The overall lessons are clear:

1. Attractive economics: Short paybacks and significant savings are achievable.
2. Co-benefits: IAQ, health, cultural preservation, and resilience enhance the case for investment.
3. Delivery models: PBC and smart HVAC retrofits provide replicable, scalable approaches for a wide range of owners.

Taken together, the evidence shows that retrofitting is not optional but increasingly a strategic necessity. As carbon constraints tighten and pressure from tenants, regulators, and financiers grows, the retrofit market will need supportive frameworks, incentives, and coordination to move from isolated examples to a citywide investment strategy. Yet, economics alone are not enough: bankable retrofits depend on contracts that translate attractive paybacks into trusted, investable projects.

42. Che, W. W., Tso, C. Y., Sun, L., Ip, D. Y. K., Lee, H., Chao, C. Y. H., & Lau, A. K. H. (2019). Energy consumption, indoor thermal comfort and air quality in a commercial office with retrofitted heat, ventilation and air conditioning (HVAC) system. Energy and Buildings, 201, 202–215.
43. ASHRAE is The American Society of Heating, Refrigerating and Air-Conditioning Engineers. It is a global professional organization that develops standards and guidelines for building systems, energy efficiency, indoor air quality, and sustainability. For example, *ASHRAE Guideline 36* sets best practices for high-performance sequences of operation for HVAC systems, while *ASHRAE Standard 90.1* is widely used as a benchmark for energy performance in buildings, see https://www.ashrae.org.
44. World Health Organization (WHO). *WHO Global Air Quality Guidelines: Particulate Matter ($PM_{2.5}$ and PM_{10}), Ozone, Nitrogen Dioxide, Sulfur Dioxide and Carbon Monoxide.* Geneva: WHO, 2021.
45. The technical details of the KINS system will be published separately by in other reports by HKUST scholars. Suffice to say in this report on financing that improved IAQ, reduced health risks, and enhanced worker productivity can significantly amplify the value of retrofits.
46. World Green Building Council. (2014). *Health, wellbeing and productivity in offices: The next chapter for green building*. London: WGBC.
47. Allen, J. G., MacNaughton, P., Satish, U., Santanam, S., Vallarino, J., & Spengler, J. D. (2016). Associations of cognitive function scores with carbon dioxide, ventilation, and volatile organic compound exposures in office workers: A controlled exposure study of green and conventional office environments. *Environmental Health Perspectives*, 124(6), 805–812. https://doi.org/10.1289/ehp.1510037.
48. Fisk, W. J. (2000). Health and productivity gains from better indoor environments and their relationship with building energy efficiency. *Annual Review of Energy and the Environment*, 25, 537–566. https://doi.org/10.1146/annurev.energy.25.1.537.
49. A Building Management System (BMS) is a digital platform that controls and monitors a building's key systems (e.g. HVAC, lighting, and power), enabling energy savings through optimisation and automation.

CHAPTER 6

BUILDING THE EVIDENCE BASE: DATA, ESTIMATION, AND DECISION-SUPPORT SYSTEMS

The case studies in Chapter 5 demonstrate that individual retrofits in Hong Kong can yield attractive payback periods and deliver multiple co-benefits. Those examples, while persuasive, remain isolated unless aggregated into a coherent picture of the retrofit opportunity across the city's building stock. Scaling retrofits to meet Hong Kong's climate and economic goals require not only capital and technical know-how but also a strong evidence base: data that identifies where the greatest savings lie, how interventions can be prioritised, and which pathways deliver the highest returns.

THE DATA CHALLENGE

At present, Hong Kong faces persistent data gaps. Although buildings account for over 90% of the city's electricity consumption and about 50% of carbon emissions, there is no unified, publicly accessible database that links building-level characteristics, such as GFA, energy consumption, age, use type, and installed systems, with actual performance. Even with the BEEAO, which shortened the reporting cycle from ten to five years, it will take time for a comprehensive dataset to emerge.

In the absence of a centralised evidence base, policymakers and financiers face uncertainty in designing effective incentives, financing mechanisms, and risk-sharing arrangements. Experience from other markets shows, however, that data gaps need not be deal-breakers: many cities have retrofit activity despite incomplete records. Hong Kong also has a comparative advantage in its extensive building design archives at the Buildings Department. What is missing is not so much the design information itself, but supporting evidence trails with independent professional assessments of design and performance quality, and facilities to verify in-situ performance.

HKUST'S DECISION-SUPPORT SYSTEM (DSS)

Bridging these gaps requires tools that can translate available information into actionable insights. Decision-support systems can play a valuable bridging role: by using existing datasets to model retrofit potential and estimate savings, they provide a practical evidence base for action today, while the city gradually strengthens its certification, testing, and verification frameworks.HKUST has developed a prototype DSS that offers indicative estimates of potential savings, not precision forecasts, helping stakeholders to prioritise opportunities and build confidence in the retrofit market.[50] The HKUST tool draws on privately sourced data and assumptions based on typical retrofit pathways to provide an initial view of energy use and carbon reduction potential across the city. Covering more than 60,000 commercial and residential buildings, the DSS visualises stock characteristics by age, height, usage type, and estimated consumption.

The DSS is not intended as a forecast or audit instrument. Rather, it can help serve as a policy and finance tool, offering an early-stage picture of relative opportunities that can guide regulatory reform, investment design, and project aggregation.

The DSS integrates multiple analytical layers. At its core is a 3D city map highlighting spatial energy intensity. Users can filter by district, building type, or year of construction to reveal patterns of consumption. Scenario calculators allow policymakers and investors to simulate the effects of different retrofit strategies.

For example, applying a 60% energy use reduction to all pre-1990 ECBs in Central District and a 30% reduction to those built between 1990 and 2010 reduces total electricity consumption from 2.87 billion kWh to 1.95 billion kWh i.e. a 32% reduction in energy demand. Based on Hong Kong's current grid emission factor (approximately 0.42 $kgCO_2$/kWh, reflecting a mix of mainly natural gas with ~25% nuclear and a small residual share of coal), this would translate into an equivalent 32% cut in associated GHG emissions.[51]

Preliminary estimates suggest total electricity consumption by Hong Kong's building stock is approximately 48 billion kWh per year. The DSS currently underestimates this by around 13% compared with EMSD figures, reflecting the limitations of private data sources and assumptions. However, this gap underscores the potential value of the required audits submissions every five years under the BEEAO into the platform. A feedback loop between mandatory disclosure, independent estimation, and continuous calibration can greatly strengthen the evidence base for retrofit policymaking.

BOX 10
Limits of Estimation and Pathways to Improvement

HKUST's DSS offers a helpful preliminary view of retrofit potential for professionals, but its reliance on assumptions, such as building age, GFA, number of floors, type, operating hours, and EUI may produce distortions, especially for buildings that have already been upgraded or operate differently from typical profiles. Labelling individual buildings on this basis may also entail legal risk, although the DSS does not claim to be accurate.

A more robust approach will be enabled by the BEEAO, which introduces disclosure of energy efficiency data for major building services systems (e.g., central air-conditioning, lifts etc). For example, a central air-conditioning system operating with a plant coefficient of performance (COP – a measure of system efficiency) of 4.5 may be shown to have around 20% savings potential compared to the latest technology achieving 5.6.

Because disclosure aligns with the 5-year energy audit cycle, building a comprehensive dataset will take time. Integrating this system-level disclosure into tools like HKUST's DSS would allow more precise and defensible estimates of retrofit opportunities, reduce uncertainty for financiers and policymakers, and strengthen the evidence base for scaling investment.

COMPLEMENTING DSS WITH DIGITAL TWINNING

While DSS provides a city-wide, portfolio-level view of retrofit opportunities, HKUST has also developed a Digital Twin (DT) platform that validates retrofit performance at the building scale. The DT integrates Building Information Modelling (BIM), real-time sensor data, and simulations across more than 60 campus buildings. Pilot studies (see Chapter 9) have shown how Computational Fluid Dynamics and energy modelling can quantify the benefits of specific interventions such as low-e glazing, not only in terms of energy savings but also indoor comfort and air quality.

Together, DSS and DT create a complementary evidence base: DSS maps opportunity and scale across Hong Kong's stock, while DT demonstrates performance outcomes with precision at the building level. For policymakers, this combination helps bridge the gap between strategic planning and project-level confidence.

OTHER ESTIMATION METHODS

The DSS is one approach for assessing retrofit potential, but it is not the only one. Academic research by another group of researchers at HKUST have begun to explore city-scale scenarios using alternative modelling frameworks. Two recent studies illustrate how different methods converge on the same conclusion: Hong Kong's retrofit opportunity is very large, though precise numbers depend on assumptions.

- **Baseline modelling:** One study used a digital twin approach (GeoBEM) to simulate over 120,000 buildings in Hong Kong. This validated baseline provided high-resolution estimates of energy use across districts and building types, highlighting offices, hotels, retail, and hospitals as the most energy intensive. While not designed to generate policy scenarios, the work confirmed that urban-scale building energy modelling is technically feasible and can provide robust baselines against which retrofit strategies may be tested.[52]

- **Retrofit and financial potential:** Another study applied five stylised retrofit measures (lighting upgrades, chiller replacements, rooftop solar PV, additional insulation, and window/façade improvements) to roughly 202,000 buildings (representing almost all of Hong Kong's stock). These measures were applied in a generic way across building categories for modelling purposes, so the results should be seen as illustrative rather than precise forecasts. The analysis combined energy savings with financial metrics such as internal rate of return (IRR) and payback period:[53]

  - **Lighting retrofits** were found to be highly attractive, with IRRs of 10%–50% and paybacks of 2–5 years across building types.

- **Chiller upgrades** produced variable results but showed strong returns in energy-intensive sectors such as schools, retail, and industry.

- **PV retrofits** offered moderate IRRs (5%–10%) with ~11-year paybacks. Importantly, the study showed that the scale of opportunity depends on financing thresholds: if investors only accept projects with IRR ≥15%, the PV market is very limited, but if the threshold were relaxed to 5% (e.g. with patient capital or incentives), the potential could in principle reach US$25 billion (~HK$195 billion) in investment and ~3.35 Mt annual CO_2 reduction.

- **Insulation and window/façade upgrades** were more challenging under the generic assumptions used in the model, producing weak or negative returns. However, more detailed studies suggest that specific measures, such as replacing single-glazed vision glass with double low-e coated glass, could deliver significant HVAC savings.[54]

Together, these studies underscore two points. First, there is strong convergence that the "low-hanging fruit" for Hong Kong lies in HVAC and lighting upgrades, with PV representing a very large opportunity if financing conditions improve. Second, while the precise returns on measures such as insulation or glass replacement depend heavily on building type and assumptions, the direction of travel is clear: there is abundant retrofit potential, and the constraint is not technical feasibility but whether the policy and financial environment enable it to be realised.

COLLABORATION WITH INDUSTRY TOOLS

While the HKUST DSS was created as a policy-oriented platform, Hong Kong's many commercial engineering companies that deliver retrofit services also maintain sophisticated in-house tools. These are typically applied on a project-by-project basis, but collectively they represent a wealth of technical capacity to estimate both building-specific and city-wide energy saving potential. With a clear government signal that retrofitting is a policy priority, there is an opportunity for collaboration between academia, EMSD and industry actors to integrate these capabilities. Such a partnership could produce more refined estimates of retrofit potential across different building types and conditions, while also strengthening the policy case for incentives and finance. By combining academic transparency, government capacities and industry practice, Hong Kong could build a robust, shared evidence base to underpin both regulation and investment.

POLICY RELEVANCE

The precise numbers from different models vary according to assumptions, but their collective message is consistent: Hong Kong's retrofit potential is very large, measurable, and technically achievable.[55] The bottleneck lies not in engineering feasibility but in finance, governance, and market design.

Together, the DSS and external studies provide complementary perspectives:

- The DSS demonstrates how decision-support tools can visualise opportunities and guide scenario planning.

- The academic studies confirm, with more rigorous modelling, the magnitude of savings and the economic rationale for prioritising certain measures.

- Industry tools, when aligned with policy frameworks, can translate this knowledge directly into implementation at scale.

For policymakers, this triangulation offers confidence that retrofit targets can be backed by credible evidence. It shows that a pipeline of investable projects exists – provided market structures allow attractive returns to be realised.

For financiers, the DSS may also provide value at the strategic rather than transactional level. By mapping energy use and retrofit potential across Hong Kong's building stock, it gives banks and investors visibility of market size, sectoral concentration, and the likely impact of future regulatory changes. This can support product development (for example, SME retrofit loans), portfolio screening, and capital allocation into green and sustainability-linked finance. When linked with the five-yearly audit data, the DSS could also create sectoral benchmarks for energy intensity, helping financiers assess relative risk and performance. While not a substitute for project-level audits or due diligence, the DSS can help establish confidence that a robust pipeline of projects exists, justifying the creation of tailored financing instruments and platforms.

CONCLUSION

In climate policy, perfect data is rarely available at the outset. What matters is establishing credible baselines, refining them over time, and making decisions with the best available evidence. The DSS, together with independent modelling studies and industry expertise, represents a strong starting point for operationalising Hong Kong's retrofit opportunity. All methods converge on the same conclusion: the city's building stock contains one of the largest untapped sources of emissions reductions, but unlocking it depends on mobilising finance, aligning regulation, and treating retrofit not as an optional upgrade but as a cornerstone of Hong Kong's climate strategy.

BOX 11
Comparing Estimation Methods – HKGFA and HKUST

A. HKGFA's Estimate: HK$3.6 billion Retrofit Potential
In its White Paper, HKGFA analysed Hong Kong office building data and classified retrofit needs into three levels – shallow, mid, and deep – each with associated cost ranges:

- Shallow: lighting fixtures, controls, digital optimization
- Mid: primarily HVAC replacement/upgrades
- Deep: civil works and major building systems

Buildings were assigned to these classes based on age, district, equipment provision, and size. For example, a 10-year-old office tower with centralized air conditioning was assumed to need only a shallow retrofit, while a 40-year-old office without centralized air conditioning might require a deep retrofit.

The market size was calculated by multiplying the number of buildings in each class by the corresponding retrofit cost. Using this classification approach, HKGFA estimated a total retrofit market potential of HK$3.6 billion.[55]

B. HKUST's Estimate: HK$3.37 billion Retrofit Potential
HKUST's approach was based on extrapolating energy savings from two retrofit case studies:

- LSK Building: retrofit reduced annual energy consumption by about 15% (applied as a proxy for newer office buildings, built after 2010).
- TAL Building: retrofit achieved about 51% annual savings (used as a proxy for older office buildings, over 50 years).

Because older buildings generally achieve greater efficiency gains from retrofits, HKUST used the average of the two case studies as a benchmark, giving an estimated 33% savings rate. Given that Grade A offices in Hong Kong are, on average, more than 30 years old, with nearly half even older, this 33% figure is likely a conservative estimate.

Office buildings consume about **8.5 TWh of electricity** each year, at a cost of **HK$10.2–13.6 billion** depending on tariff rates (HK$1.2–1.6/kWh). Applying the 33% savings rate to the low-end cost estimate of HK$10.2 billion results in potential annual savings of **HK$3.37 billion**.

Thus, HKUST's method estimates market potential by projecting energy savings from representative case studies across all Hong Kong office buildings. Compared with HKGFA's bottom-up classification of building stock, this is a more approximate, top-down estimate, but it arrives at a similar figure.

50. The tool is available on request.
51. The estimate uses Hong Kong's grid emission factor of approximately 0.42 $kgCO_2$/kWh, based on the territory's 2022–23 fuel mix of mainly natural gas, ~25% nuclear imports, and a small residual share of coal and renewables. Electrical and Mechanical Services Department. (2023). *Hong Kong energy end-use data 2023.* HKSAR Government. https://www.emsd.gov.hk/en/energy_efficiency/energy_end_use_data_and_consumption_indicators/hk_energy_end_use_data_2023/index.html.
52. Zhang, S., et al. (2023). *GeoBEM: A geospatial computing empowered framework for urban-scale building energy modeling.* Energy and Buildings, 291, 113,351. https://doi.org/10.1016/j.enbuild.2023.113351.
53. Internal Rate of Return (IRR) is the discount rate that makes the net present value of a project's cash flows equal to zero, thus accounting for the timing of savings or revenues. It differs from Return on Investment (ROI) noted in Chapter 7, which is a simpler ratio of net gains to upfront costs without considering the time value of money. Both are used in this report: IRR in modelling studies and ROI in industry case analyses.
54. Zhang, S., et al. (2025). *Decarbonizing the building sector through energy efficient retrofit measures: The cost and the benefits.* Unpublished manuscript, Department of Civil and Mechanical Engineering, The Hong Kong University of Science and Technology.
55. HKGFA's White Paper estimated a retrofit market opportunity of HK$3.6 billion for existing office tower buildings.

CHAPTER 7

PORTFOLIO APPROACHES TO RETROFIT AND DECARBONISATION POTENTIAL

Previous chapters have demonstrated that individual retrofit projects can deliver attractive payback periods and significant co-benefits. Yet, Hong Kong's challenge extends far beyond the building-by-building level. To unlock the scale of energy savings required for meeting its climate goals, the city must mobilise investment across its building stock. This means understanding retrofits not only as technical interventions, but also as a portfolio-level challenge for asset owners, developers, and financiers.

AGGREGATE RETROFIT POTENTIAL

Research has consistently shown that Hong Kong's existing building stock represents one of the city's largest untapped sources of emissions reductions. Studies noted in this report show that widespread retrofits could deliver attractive reductions in electricity consumption, contributing materially to Hong Kong's carbon neutrality targets. The studies emphasise that while technologies are well established, the critical barrier lies in converting potential into pipeline, ensuring that retrofit opportunities are identified, funded, and delivered at scale.

PORTFOLIO-LEVEL APPROACHES

A growing number of financial institutions, investment managers and developers are beginning to view retrofits through a portfolio management lens. Instead of assessing upgrades one building at a time, they are analysing their entire property portfolios to determine where to invest, where to monitor, and in some cases, where to divest.

One recent case illustrates this shift. A global investment bank, UBS AG, shared demonstrative information with HKUST for this report of how such a portfolio analysis could be applied on many real estate assets using an advanced carbon and retrofit risk screening tool co-developed with a third-party engineering consulting company. The portfolio comprised of 10 hypothetical commercial buildings, with a combined floor area of over 220,000 m^2, annual electricity consumption of roughly 35 GWh, and emissions of about 5,000 tonnes of CO_2 per year. The objective is to provide a holistic comprehensive overview, incorporating financial aspects to guide investment decision-making by asset owners to prioritize the work required to monitor, retrofit, divest assets, considering the potential environmental benefits and impact delivered. This approach of combining financial, engineering and sustainability expertise brings further credibility and integrity in the results and differentiates from current practices that simply consider assets, or project works on a standalone basis.

The analysis revealed that three assets were already stranded under emerging climate standards, with a further two projected to become stranded by 2030 unless retrofits were undertaken. By investing around €5 million by 2030, an investment manager could align its portfolio with near-term climate targets, generating annual energy cost savings of €2 million and achieving an average ROI[56] of 41%. Looking further ahead, an additional €72 million in investments by 2050 would deliver a 63% cumulative emissions reduction/avoidance (equivalent to nearly 50,000 tonnes of CO_2, of environmental benefit and carbon cost saving of €7.5 million in a hypothetical scenario of €150/tonCO_2 carbon price) while maintaining asset value and competitiveness.

Crucially, the institution adopted a tiered decision-making strategy:

- **Monitor** – assets that already met performance thresholds and required no immediate action.
- **Retrofit** – assets with attractive ROI (>3%) where intervention would deliver strong financial and carbon savings.
- **Divest** – assets deemed non-viable (ROI <3%) where exit was preferable to continued investment.

This approach demonstrates how retrofit decisions are increasingly framed as strategic portfolio management rather than isolated technical upgrades. By integrating financial, technical, and carbon risk data, asset owners can prioritise investments, reduce exposure to stranding risk, and align with net-zero pathways. Furthermore, such structured investment approaches can demonstrate how their actions contribute to meeting the relevant jurisdiction's overall climate goals in a tangible and transparent manner, whilst helping the individual asset owners mitigate their own regulatory non-compliance risks.

BOX 12
Retrofit REIT-like Issuance in Mainland China

In Mainland China, financial innovation has begun to explore REIT-like structures for clean energy and infrastructure assets, offering a potential pathway for scaling retrofit finance. The principle is simple: aggregate multiple retrofit projects into a portfolio and securitise their predictable cash flows into a product that can be sold to institutional investors.

For ESCOs, such structures provide a way to recycle capital. Once projects are operational and generating verified savings, they can be transferred into the REIT-like vehicle, freeing up balance sheet capacity for new investments while still allowing the ESCO to earn ongoing management fees. For investors, particularly state-owned insurers and long-term asset managers, retrofit REITs would offer stable, sustainability-linked yields with relatively low risk.

There are precedents. Towngas Smart Energy Company Limited successfully issued REIT-like instruments backed by solar assets, demonstrating market appetite for securitised sustainability products. Applying the same logic to retrofits could unlock a new investor base and accelerate project scale-up, especially if supported by public policy or blended finance guarantees.

For Hong Kong, the lesson is twofold. First, retrofit securitisation in Mainland China could create opportunities for cross-border collaboration, with Hong Kong serving as a platform for structuring, certification, and international investor access. Second, the approach illustrates how retrofits can be transformed from fragmented, project-level transactions into scalable, tradable assets within capital markets.

IMPLICATIONS FOR HONG KONG

The relevance of such portfolio-level thinking for Hong Kong is significant. Much of the city's Grade A office and retail space is concentrated in the hands of a few major developers and financial institutions. These actors are uniquely positioned to adopt portfolio screening tools, spread investments across multiple assets, and balance risks over time.

Moreover, public-sector institutions, such as the Housing Authority, Housing Society, Urban Renewal Authority, and West Kowloon Cultural District could apply similar methods to their own property portfolios. By doing so, they would not only reduce operating costs and emissions but also provide a powerful signal to the market that large-scale retrofitting is both viable and expected.

Portfolio approaches, help prioritise asset interventions and direct finite public and private financial resources in a way that balances financial and environmental benefits. More importantly, they strengthen the case for creating enabling financial mechanisms, such as the *Retrofit Finance Platform* discussed in Chapter 4. By standardising data (e.g., through the BEEAO's 5-yearly audit and EUI reporting) and aggregating opportunities, Hong Kong could accelerate the flow of capital into retrofits at scale.

CONCLUSION

This chapter extends the discussion from individual retrofit cases (Chapter 5) to the system level. It shows that the economics of retrofits remain compelling not just for single buildings but for entire portfolios, provided owners adopt a strategic view of risk and value. Portfolio screening can identify stranded assets, guide targeted investment, and deliver robust returns.

For Hong Kong, the lesson is clear: the opportunity is not constrained by technology, but by governance, finance, and strategic prioritisation. Portfolio-level analysis offers a way to reframe retrofits as essential to protecting asset value and ensuring long-term competitiveness. If embraced by both private developers and public bodies, this approach could help turn Hong Kong's retrofit potential into a city-wide programme of climate action.

56. Return on Investment (ROI) is a ratio of net gains to upfront costs, widely used in industry to communicate retrofit benefits. By contrast, the Internal Rate of Return (IRR) as noted in Chapter 6 is a time-adjusted measure that accounts for the timing of cash flows. Both indicate profitability, but IRR provides a fuller financial assessment, while ROI offers a straightforward snapshot.

CHAPTER 8

FINANCING THE RETROFIT TRANSITION

Even if the technical and economic case for retrofitting Hong Kong's building stock is clear, the transition will remain sluggish without financing models that align incentives, reduce risk, and reward early action. Retrofitting is no longer a problem of technology; it is a challenge of governance, finance, and market design. These issues point directly to the relevance of PBC, a mechanism through which public and private sector actors – government, banks, investors, and market intermediaries – can collaborate to unlock retrofitting at scale. By creating trust in outcomes and reducing barriers to investment, PBC can help to realize the Chief Executive's 2025 Policy Address commitment to "drive the market to accelerate carbon reduction in existing buildings."[57]

FINANCING AS THE BOTTLENECK & PRESSURE, CONFIDENCE, AND VISIBILITY

A critical bottleneck lies in financing. Even where retrofit projects demonstrate attractive payback periods, owners are often hesitant to invest. The reasons are well rehearsed: limited access to capital, competing business priorities, split incentives between landlords and tenants, and the perceived complexity of managing building works. For many asset owners, the default remains to defer action unless compelled or rewarded. Yet, unlocking finance is not just about money – it is also about creating pressure, confidence, and visibility. Retrofitting fits squarely within these priorities: it offers measurable carbon reductions in a sector responsible for 50% of Hong Kong's emissions, and it saves energy for the economy as the cost of electricity is expected to rise in the future. Complementary efficiency policies, such as tightening minimum appliance standards for households, would help curb overall demand growth and reinforce the business case for retrofits by reducing long-term exposure to higher electricity prices. In turn, lower and more predictable demand trajectories improve the creditworthiness of retrofit projects and the stability of financing flows.

Ultimately, unlocking finance is not only about capital flows but about trust. Banks and investors can only scale up lending when contracts allocate risks clearly, repayment is tied to verified outcomes, and disputes are minimised. This is why PBC, in its various forms, is central to mobilising retrofit finance.

THE ROLE OF BANKS AND INVESTORS

From the financial sector's perspective, retrofits represent a significant and relatively low-risk use of green capital, particularly when projects are aggregated and supported by performance data. Local and internationals banks are under mounting scrutiny from regulators, shareholders, and even climate-conscious clients to align their loan books with climate goals. Many have adopted net-zero commitments with interim milestones, creating pressure to identify bankable green projects. Green and sustainability-linked loans are expanding and retrofitting fits squarely within the decarbonization priorities of commercial lenders.

Green loans, however, require credible criteria and documentation. The adoption of the Hong Kong Taxonomy for Sustainable Finance published by the HKMA[58] for defining green retrofit projects is a good means to assure lenders that the proceeds are used in truly environmentally sustainable activities. The HKGBC, in conjunction with HKGFA, has published an Operational Guide[59] to help the building and construction sector implement the Hong Kong Taxonomy. Once financing is issued, lenders still expect verifiable evidence of energy savings and/or carbon reductions. This underscores the importance of standardized frameworks for measurement, reporting, and verification (MRV) that give financiers confidence in outcomes. As earlier chapters have argued, the periodic energy audit framework under the BEEAO (currently set at 5-year intervals), if well implemented, can provide a performance baseline.

Investors, too, are increasingly motivated by climate alignment. Transition finance instruments, sustainability-linked bonds, and green bonds are proliferating in Asian markets, and Hong Kong's position as a regional financial hub provides a unique opportunity to channel capital not only from local banks but also from cross-border investors seeking credible, high-impact decarbonization opportunities. By aggregating retrofit demand and linking it to measurable outcomes, Hong Kong could become a leading platform for channelling international capital into Asia's built environment.

This trajectory is reinforced by HKMA Sustainable Finance Action Agenda (see Chapter 4), which requires banks to prepare Paris-aligned transition plans, strengthen sustainability disclosures, and expand green and sustainable bond issuance. Retrofitting fits squarely within this agenda: it provides measurable decarbonisation outcomes, creates investor-ready projects for sustainability-linked lending.

RETHINKING FOR LENDERS: FROM COLLATERAL TO CASH FLOW

A structural challenge in financing retrofits lies in the way banks currently assess credit risk. In Hong Kong, as in many other markets, lending for building improvements is typically tied to the collateral value of the property. This approach limits the scope for deep retrofits: if a building's appraised value is modest, the owner may not be able to borrow enough to fund substantial upgrades, even if those upgrades would generate strong savings and extend the building's useful life.

Moreover, surveyors rarely assign higher valuations to buildings that have undergone retrofits, unless improvements are translated into higher rents or occupancy rates. As a result, the conventional model provides little financial recognition of retrofit benefits, reinforcing the view that such projects are a cost rather than an asset-enhancing investment.

By contrast, in infrastructure and project finance, lending is often based on the predictability of future cash flows rather than the resale value of the underlying asset. Repayments are secured through contracted revenues, such as utility payments or availability fees. A similar principle can be applied to building retrofits: financing could be underwritten based on verified energy savings generated through PBC. This would shift the paradigm from collateral-driven lending to cash-flow-based lending, bringing retrofits closer to the treatment of infrastructure assets.

Such a shift would require banks to build confidence in M&V standards, as well as to collaborate with insurers and rating agencies to treat energy savings as credible revenue streams. It would also call for regulators and government to encourage innovative lending frameworks that recognise the risk-reduction and value-preservation benefits of retrofitting. Moving in this direction would enable banks to play a catalytic role in scaling retrofits, aligning financing practices with sustainability objectives rather than being constrained by conventional property valuation.

GOVERNMENT'S CATALYTIC ROLE

While banks must evolve beyond collateral-based lending to unlock private capital for retrofits, their efforts will only gain traction if matched by clear policy signals and supportive frameworks from government. The HKSAR Government's role is to set direction, reduce uncertainty, and activate early markets. Without regulatory pressure or clear signals of future tightening, asset owners face little compelling reason to act. Government therefore has two primary levers: regulation (the stick) and incentives (the carrot).

Box 13
Economies of Scale in Portfolio Retrofits

Retrofitting at the portfolio or city level creates opportunities that single buildings cannot achieve on their own. Buildings constructed around the same time often share similar technologies, making it possible to group them for parallel upgrades or to stage improvements across assets. This can reduce costs, improve comfort and resilience, and extend building lifespans. New York City's Retrofit Accelerator illustrates how this can work in practice. By using city-wide benchmarking and audit data, the programme helps owners identify retrofit opportunities across multiple properties, guiding them to financial incentives and technical support. The result is faster, more cost-effective action at scale, showing the value of treating buildings as part of a system rather than as isolated assets.[60]

BOX 14
Strengthening the BEEAO

Moreover, the BEEAO could be strengthened again during the next term of administration (2027-2032), such as:

- Shorten energy audit reporting intervals from five to three years.
- Including hotels and high energy hospitality users.
- Introduce minimum energy performance standards for older buildings, or high energy consuming building services systems, and
- Trigger mandatory retrofits at point-of-sale or major renovation.

On regulation, the BEEAO reforms were a significant step forward, but further tightening will be needed before 2030. Potential measures include shortening the audit reporting intervals from five to three years, phasing in minimum performance standards for older buildings (especially ECBs), or large energy consumers (such as central air-conditioning plant), and requiring retrofits at points of sale or major renovations. These measures would embed retrofitting into normal market cycles rather than leaving it as a discretionary exercise.

On incentives, the policy toolbox is broader than often recognized. Fiscal levers could include property rate reductions for compliant buildings, accelerated depreciation or tax deductions for retrofit investments, and interest subsidies for green loans. These could be tiered based on the depth of retrofit or the speed of compliance, rewarding early and ambitious movers. The HKSAR Government has successfully deployed similar schemes before, such as the early-scrappage programme for Diesel Commercial Vehicles.[61]

Public sector leadership is equally important. By aggregating retrofits across its vast portfolio of schools, hospitals, offices, and public housing, the HKSAR Government could create a large and visible pipeline of projects. For example, the HKSAR Government could identify a package of buildings for retrofit to be carried out over a specific period (for example over 20 years) to achieve specific energy and carbon reductions and could call for PBC proposals. Such a large project would likely attract strong international interest. Public sector projects could serve as market exemplars, de-risking PBC and other financing structures, as well as building private-sector confidence. As argued in Chapter 4, public sector buildings could act as catalysts, demonstrating proof of concept and helping to standardize contractual and financing models for replication.

BOX 15
Expanding the Financing Toolbox

The HKGFA White Paper highlighted a diverse menu of financing instruments, including:

- **Green loans and bonds**, supported by performance data from energy audit reporting.
- **Transition finance**, which can support owners of older, inefficient stock to move toward compliance.
- **Sustainability-linked loans**, linking interest rates to verified energy savings.
- **Blended finance models**, in which concessional or public capital de-risks private investment.
- **Carbon credit frameworks**, where measurable retrofit-related emissions reductions could create additional revenue streams.

INSIGHTS FROM HONG KONG RESEARCH

The CEPU Report underscored that retrofitting is as much a financial challenge as it is a technical one. It recommended phased tightening of regulatory standards, a stronger role for EPC, and clearer financial signals to building owners – the reality that without new financing frameworks, the retrofit market would remain underdeveloped even in the face of attractive returns. Similarly, the HKGFA White Paper stressed that finance is the "missing link" between Hong Kong's climate goals and delivery in the built environment.[62] The White Paper also highlighted the importance of data transparency, performance benchmarking, and aggregation to attract capital at scale. It identified specific pathways to mobilize capital: expanding green and sustainability-linked loans, developing transition finance frameworks, incentivizing blended finance to de-risk projects, and exploring the monetization of carbon credits from verifiable emissions reductions. It emphasized the need for market infrastructure to lower transaction costs and link building owners with financiers.

Together, these two reports converge on a critical point: Hong Kong has the technical know-how and financial depth but lacks the integrated policy-cum-finance architecture to mobilize capital at scale. The proposed *Retrofit Finance Platform* discussed in Chapter 4 offers an idea for a way forward. By embedding periodic audit performance data into investor due diligence and integrating banks with public agencies, such a platform could transform isolated projects into a scalable asset class.

BOX 16
Carbon Credits as a New Value Stream for Retrofits

There is growing interest in whether verified energy savings from building retrofits could be monetised through carbon credits. Such an approach would create an additional revenue stream to strengthen project bankability, especially for owners hesitant to commit capital upfront.

For Hong Kong, the opportunity lies in building on existing regulatory and financial foundations:

- **Baselines and Verification** – The new five-year disclosure requirements under the BEEAO provide transparent energy data that could serve as credible baselines. Independent M&V protocols aligned with international standards would be essential to ensure the integrity of credits.

- **Market Development** – A dedicated platform for retrofit-related credits could reduce transaction costs and establish clear eligibility criteria, distinguishing between mandatory compliance upgrades and voluntary retrofit measures. Demonstration projects within the government's building portfolio could provide early proof of concept and market confidence.

- **Finance and Integration** – Properly designed, retrofit carbon credits could complement Hong Kong's green finance ecosystem, serving as additional value for sustainability-linked loans and bonds. Linking credits to existing certification schemes already included in the Hong Kong Taxonomy would strengthen credibility and alignment with global voluntary markets.

While challenges remain, such as with multi-owner buildings as to who own the credits, ensuring additionality and avoiding over-crediting, a retrofit-focused carbon credit framework could reinforce Hong Kong's positioning as a green finance centre while accelerating uptake of deep retrofits.

BOX 17
Sustainability-Linked Commercial Mortgages with Retrofit Undertakings

A further financial innovation worth considering is the development of sustainability-linked commercial mortgages that embed retrofit undertakings directly into refinancing arrangements. Instead of treating retrofits as a separate financing exercise, this approach ties them to natural refinancing cycles when owners seek to reduce financing costs or improve liquidity.

The concept is straightforward. Building owners would commit, as part of their mortgage agreement, to carry out agreed retrofit measures within a defined timeframe. A dedicated retrofit tranche could be included in the mortgage to cover the required capital expenditure, ensuring that owners retain "skin in the game" rather than passing all costs to the ESCO. Banks, in turn, would administer performance-linked incentives, for example, partial cash interest refunds when retrofit milestones are met, verified through established M&V protocols. This design would shift the payer role from tenants or owners to the bank, creating stronger alignment of incentives between owners and ESCOs while reducing disputes.

Such mortgages would also broaden the scope of performance measurement beyond electricity savings to include ESG co-metrics such as IAQ, thereby enhancing both financial and social returns. For ESCOs, predictable payments administered by banks would reduce cash flow volatility and strengthen their capacity to access credit. For owners, the bundling of retrofit obligations into mortgages could lower adoption barriers, reduce contractual complexity compared to many-to-many PBC negotiations, and deliver predictable financing conditions.

The policy rationale is equally compelling. With commercial property values under pressure and refinancing volumes high, embedding retrofit obligations into mortgages could accelerate upgrades at scale, while supporting Hong Kong's ambitions as both a green finance hub and a leader in building decarbonisation. Properly designed, sustainability-linked commercial mortgages could become a powerful addition to the city's financing toolbox, aligning private capital with public climate objectives.

VALUATION PRACTICES AND FINANCING CONSTRAINTS

Even where financing products exist, the effectiveness of retrofits in attracting capital depends heavily on how buildings are valued. In Hong Kong, property valuations remain largely comparables-based (i.e. (i.e., tied to recent market transactions of similar buildings rather than future operating performance), with little adjustment for improved energy efficiency or resilience. Owners who have undertaken deep retrofits often report that surveyors do not assign significantly higher valuations to their buildings, even when operating costs are reduced and indoor conditions are enhanced. This undermines the case for collateral-based lending, since loans are linked to static appraised values rather than to the forward-looking benefits of retrofit investment.
International evidence suggests that valuation practices can evolve. In the United States and Europe, buildings with recognised green certifications (such as LEED, ENERGY STAR, BREEAM, or NABERS) have been shown to command higher rents, achieve stronger occupancy, and, in some markets, sell at premium prices. These market signals have encouraged lenders to experiment with green mortgages and other preferential products. However, the uplift is most visible when efficiency gains are paired with certification and market recognition, not simply from retrofit measures alone.

For Hong Kong, this points to the need for valuation reform alongside financing innovation. If retrofitted buildings continue to be valued as if no improvements have been made, retrofits will be perceived primarily as a cost rather than as a value-enhancing strategy. Aligning valuation practices with sustainability outcomes, by recognising lower operating costs, improved risk resilience, and enhanced tenant well-being, would help shift perceptions and support a financing ecosystem that rewards owners who invest in decarbonisation.

TOWARDS SCALABLE MODELS

Performance-based models have relevance for Hong Kong. They allow building owners to reduce or defer upfront capital expenditure, with repayment tied to verified savings. As highlighted in previous case studies, EPC and its variants can make retrofits bankable, particularly for owners with limited liquidity. Yet, as earlier chapters made clear, PBC require trust, standardization, and supportive policies to scale.

Performance-based contracts are not "free retrofits" – they involve shared savings or service fees to ESCOs but they lower barriers by linking costs to outcomes. For smaller landlords, this flexibility is especially important as they face competitive pressure from large developers already investing in green upgrades to attract international tenants with ESG commitments. Financing models such as EPC and its variants can therefore deliver both climate benefits and strategic market repositioning.

TABLE 3. SUMMARY OF TYPES OF TOOLS AND SPECIFIC INSTRUMENTS AND ACTIONS

Party	Type of Tool	Specific Action
1. Government Tools	Regulation	Tighten BEEO (e.g. BEEAO in 2025) & relevant Codes
	Fiscal	Property rate rebates, tax deductions, interest subsidies for green loans
	Risk Mitigation	Revolving Guarantees for ESCOs, pilot grants for certain types of older buildings
	Demand Aggregation	Public sector retrofit programme; retrofit pipeline platform
	Capacity Building	New training standards; funding training; prepare retrofit guidelines, such as how EPC works
2. Banks/Lenders	Financing Instruments	Green loans, sustainability-linked loans, project finance for EPC and its variant contracts
	Tracking Verification	Require MRV of energy savings, link loan rates to outcome performance
3. ESCOs/EPC Providers	Service Delivery	Design and implement retrofit works, enter into performance-based contracts
	Risk Sharing	Take partial performance risk (guaranteed or shared savings model)
4. Building Owners	Strategic Adoption	Use EPC/ESA/BOOT to defer capex, pursue green loans, improve asset competitiveness
	Value Realization	Market greener buildings to tenants, use IAQ/energy data for ESG and rental advantage

CONCLUSION

The pathway to mass retrofitting in Hong Kong will not be achieved through isolated pilots or voluntary action. It requires predictable regulation, financial architectures that reward ambition, and platforms that reduce risk and transaction friction. The HKSAR Government must play a catalytic role by anchoring demand, de-risking projects, and sending strong policy signals. The financial sector, in turn, must leverage Hong Kong's global hub status to mobilize both domestic and international capital into the built environment.

The evidence is clear: attractive payback periods alone will not deliver market transformation. Retrofitting requires an enabling ecosystem of governance, finance, and market design. With deliberate coordination, Hong Kong has the potential not only to meet its climate targets but to position itself as a leader in green finance for the built environment. The next chapter explores how PBC can be structured and scaled as a cornerstone financing model to realize this ambition.

57. The Chief Executive's Policy Address 2025, para 235, https://www.policyaddress.gov.hk/2025/en/.
58. Hong Kong Monetary Authority. (2025, Sep 8). Phase 2A Prototype of Hong Kong Taxonomy for Sustainable Finance [Press release / Enclosure]. https://www.hkma.gov.hk/eng/news-and-media/press-releases/2025/
59. Hong Kong Green Building Council & Hong Kong Green Finance Association. (2025, September). Operationalising the Hong Kong Taxonomy for Sustainable Finance: A guide for the building and construction sector. https://hkgbc.org.hk/eng/resources/publications/HKGBC-Publication/Guidebook/Operationalising-HK-Taxonomy.pdf.
60. NYC Environmental Protection. (n.d.). *NYC Retrofit Accelerator*. City of New York. https://www.nyc.gov/assets/dep/downloads/environment/education/education-resources/education-publications/education-publications/education-publications/2021/2021/12/16/nyc-retrofit-accelerator.pdf.
61. In 2013, the HKSAR Government introduced a scheme to phase out Diesel Commercial Vehicles to retire old diesel vehicles to improve air quality. The scheme included subsidies for early scrappage, where later adopters received lower subsidies. There were also tax breaks and fee waivers (discounts on First Registration Tax and license fees for replacements), see Environmental Protection Department, HKSAR. (2013). *Phasing out of pre-Euro IV diesel commercial vehicle. HKSAR Government*. https://www.epd.gov.hk.
62. Mok, Lionel. "Hong Kong: The Missing Link for Asia's Green Finance Boom." *Green Central Banking*, 22 May 2025, https://greencentralbanking.com/2025/05/22/hong-kong-green-finance-missing-link-for-asia/.

PBC AS A SCALABLE FINANCE MODEL FOR HONG KONG

Various types of PBC have been recognized internationally as a powerful mechanism to accelerate building retrofits. By linking repayment directly to verified energy savings, it allows building owners to undertake efficiency upgrades without large upfront capital outlays, while giving ESCOs incentives to deliver results. In principle, such contracts directly address two of the most persistent barriers in Hong Kong's retrofit market: high upfront costs (capex) and mistrust over actual performance.

Despite its economic logic and international track record, PBC has not been widely adopted in Hong Kong. The paradox is clear: while retrofits consistently show attractive payback periods, as seen in Chapter 7, uptake remains limited because the enabling conditions for PBC have not yet been fully established.

International and local practice shows there is a wider family of performance-based service models: EPC, ESAs, EaaS, and BOOT apply the same principle, linking repayment to delivered outcomes, but use different contractual formats to suit owner preferences, asset types, and financing arrangements (see Chapter 4).

BOX 18
Building Transition: Financing Market Transformation

The World Green Building Council's report Building Transition: *Financing Market Transformation* report (2025) highlights the strategic importance of EPC-like models in enabling market transformation. It recommends financing products that offer "as-a-service" retrofit solutions, enabling shared savings and inclusive access to energy upgrades. Its endorsement of performance-based, zero-capex models reflects growing global support for mechanisms that align incentives across stakeholders.[63]

BOX 19
Core Advantages of PCB/EPC

PBC/EPC's attraction lies in its alignment of incentives. Under a PBC/EPC arrangement, an ESCO undertakes retrofit works, guarantees a specified level of energy savings, and recovers costs from the verified savings over time. This offers:

- **Risk Sharing:** Technical and performance risk is shifted to the ESCO.
- **Financing Flexibility:** PBC/EPC can be structured as shared-savings or guaranteed-savings contracts.
- **Performance Assurance:** Independent M&V gives financiers and owners confidence.
- **Bankability:** Predictable cash flow makes projects more attractive to lenders when linked with green finance instruments.
- **Market Discipline:** ESCOs only get paid if savings are achieved, creating transparency and accountability.

Other variants/models follow the same logic but with different structures:

- ESA – Owners pay only for verified savings, reducing technical and financial risk.
- EaaS – Owners subscribe to a service (e.g. cooling (CaaS), solar power) with zero capex, while the provider finances, owns and operates the equipment.
- BOOT – Suitable for long-life assets, where the provider finances, owns, and operates a system (e.g. chiller plants) before transferring ownership.

Together, these variants show that the "as-a-service" approach to financing is gaining traction globally and in Hong Kong.

BOX 20
Serving Different Risk Profiles & Owners

Typical PBC/EPC models and its variants serve different risk profiles and ownership preferences:

- In the Guaranteed Savings model, the ESCO commits to a specific level of savings and compensates the owner if targets are not met.
- In the Shared Savings model, the owner and ESCO agree to split the realized savings over a defined period.
- Some projects involve Full-Service EPCs, where the ESCO arranges financing, engineering, implementation, and monitoring, acting almost like a turnkey delivery partner.

BOX 21
"How do I know the savings are real?"

Owners often ask: "How do I know the savings are real?" To address this, the use of certified M&V professionals and adherence to international protocols such as those from the Efficiency Valuation Organization are critical. As Hong Kong builds its PBC market together with its variants, it must invest in the infrastructure of trust, not just technical performance but verifiable, independently audited performance outcomes.

A related concern is whether owners receive the most advantageous retrofit proposal in the first place. Without technical knowledge, clients may accept suboptimal solutions with longer payback periods or higher operating costs. To protect clients and strengthen outcomes, tendering processes could require ESCOs to submit multiple technical options, each with clear payback periods, savings estimates, capital costs, and non-tangible benefits. This enables building owners to compare alternatives transparently and select the option that best aligns with their objectives, reducing mistrust and improving project value.

KEY BARRIERS TO UPTAKE

A consistent message from market feedback and policy reviews is that PBC remains poorly understood and lack of knowledge and trust by building owners. Its variants are also relatively new. Several interrelated challenges explain this hesitation:

- **Unfamiliarity with contracts:** Many owners do not fully understand how various PBC arrangements work.
- **Perceptions of risk:** Owners often doubt whether promised savings will materialize, while ESCOs worry about clients changing building operations in ways that affect performance. This mutual uncertainty undermines confidence.
- **Lack of standardization:** In Hong Kong, there are no widely adopted standard contract templates or sector-wide protocols. Every contract must be negotiated afresh, increasing transaction costs and slowing adoption.
- **Limited demonstration:** With few projects showcased publicly, owners and financiers lack reference cases that prove the model works locally, although more examples are now available for study. This reinforces caution and "wait-and-see" attitudes.

These barriers mean that, although PBC can de-risk retrofits in theory, in practice it is still perceived as risky and complex. Overcoming this gap requires deliberate interventions by government and industry leaders.

PUBLIC SECTOR AS A CATALYST

The HKSAR Government is uniquely positioned to demonstrate PBC at scale and create the market confidence needed for wider uptake.

- **Government-led retrofits:** By retrofitting public buildings or even infrastructure under performance-based contracts, the government could aggregate demand, demonstrate success, and provide financiers with a transparent pipeline of projects backed by verifiable data. Linking such projects to the proposed *Retrofit Finance Platform* (Chapter 4) could further enhance visibility and market credibility.

- **Learning cases from public institutions:** Work with public sector institutions that are actively exploring such contracts (see below). Their journeys, if documented and shared, can serve as powerful "learning cases" for the wider market. Similarly, HKUST's upcoming PBC project provide opportunities for a major academic institution to open its experience for peer learning, showing how PBC can work in complex, high-usage facilities.

- **Green bonds for public retrofits:** The government could also raise green bonds to fund performance-based retrofits of specific groups of publicly funded facilities (such as schools and universities). These projects would not only cut emissions but also serve as practical case studies for professionals in built environment and finance, as well as students to embed knowledge in the next generation.

In short, the government and public sector can be the first movers that de-risk PBC for everyone else.

STANDARDIZATION AND CAPACITY BUILDING

Scaling PBC requires professionalization of the sector and trust-building across stakeholders.

- **Standard contracts:** To build market confidence, EMSD, working with HKGBC, HKGFA, and professional bodies such as the Business Environment Council and the Law Society etc., could develop model PBC contracts with adaptable options for different building contexts. Standardization would help demystify such contracts, reduce negotiation costs, and accelerate adoption. Beyond the traditional shared-savings form, modified approaches should also be considered. For example, contracts based on fixed repayment by the owner over the contract period (reflecting the capex incurred and profit margin of the ESCO), or EPC, ESA, EaaS and BOOT models. These variations can address concerns about uncertainty in measuring savings, while still allowing owners to benefit from deferred payments and upgraded building assets.

- **Training programmes:** They could also design training for ESCOs, building managers, and financiers covering:
  - M&V protocols,
  - Contract management, and
  - Risk allocation and dispute resolution.

By equipping practitioners with shared knowledge and tools, these programmes would strengthen trust and professionalize the retrofit industry.

- **Peer learning:** Moreover, commercial building owners who have completed or are piloting PBC could be encouraged to share their experience with others. Structured workshops, case documentation, and professional forums can make PBC less abstract and more accessible.

HARNESSING TECHNOLOGY AND INTERNATIONAL LESSONS

Emerging international practice shows how PBC can evolve with technology to deliver even greater results.

- **AI and predictive maintenance:** ESCOs are increasingly embedding artificial intelligence into PBC to optimize chiller operation, detect anomalies, and maximize efficiency.

- **Digital twins:** Virtual models of buildings enable continuous optimization and more accurate forecasting of savings, reducing disputes over performance.

- **Post-retrofit monitoring:** These tools also improve the evidence base for verifying outcomes, which is crucial for financing models that depend on performance data.

For Hong Kong, integrating these innovations into PBC would enhance transparency, reduce uncertainty, and align with the city's ambition to be a leader in green finance and smart city solutions.

BOX 22
Behavioural Change

Behavioural change is another underappreciated benefit embedded in well-designed PBC programmes. It is estimated that 3%–5% of building energy savings can come from user behaviour improvements alone. Some PBC incorporate education campaigns, tenant dashboards, and gamified energy performance tools, showing that they can also drive a cultural shift in energy use among occupants.

POSITIONING PBC AS HONG KONG'S RETROFIT FINANCING TOOLKIT

The analysis in this chapter makes clear that Hong Kong does not face a technology or payback problem in retrofitting its buildings – it faces a confidence, governance, and market design problem. PBC and the classic EPC format is the keystone model because it directly links repayment to performance, shifts technical and financial risks to service providers, and creates the bankability that lenders require.

Yet the classic EPC is only part of the picture. International and local practice demonstrates that EPC has close variants, ESAs, EaaS, and BOOT, all of which apply the same principle of performance-linked repayment but with different contractual structures. For Hong Kong, the significance is twofold. First, recognising EPC as part of this broader family lowers perceived risk by showing that performance-based financing is not an isolated experiment, but an evolving set of tools already deployed worldwide. Second, it increases choice and adaptability: building owners with different risk appetites, time horizons, and asset profiles can select the model that best fits their circumstances.

The public sector has a critical role to play in mainstreaming these approaches. By piloting EPC, ESA, EaaS and BOOT contracts across its extensive portfolio of schools, hospitals, offices and even major energy consuming infrastructure, government can create demand certainty, demonstrate workable templates, and provide financiers with verifiable case studies. At the same time, standardisation of contracts, capacity building for ESCOs and financiers, and integration of digital verification tools are essential to lower transaction costs and build trust.

Hong Kong can position PBC as the cornerstone of a *Retrofit Finance Platform* – an integrated system where regulation, finance, and market practice converge. In doing so, the city can accelerate the retrofitting of its existing building stock, unlock capital flows into one of its largest sources of carbon reduction, and reinforce its standing as a global hub for green finance.

A: THE LEE SHAU KEE (LSK) BUSINESS SCHOOL BUILDING AT HKUST

At HKUST, the LSK Business School Building has been selected as a demonstration project to showcase how EPC can work in practice. This demonstration project answers the call of the Chief Executive's Policy Address 2025 that envisions developing Hong Kong into a "demonstration base for green technology" that includes accelerating "carbon reduction in existing buildings".[64]

The LSK Business School Building, completed in 2013, has a GFA of 24,000 m^2. It houses offices, classrooms, and food-and-beverage outlets, serving almost 3,650 students and nearly 600 staff. With annual electricity use of 2.84 million kWh (including ~1 million kWh for cooling), it is not an old or poorly managed building. Its baseline EUI is around 165 kWh/m^2/year, typical of newer ECBs in Hong Kong. Yet, rough analysis shows that retrofits could still reduce annual consumption by 10%–15% (≈284,000–426,000 kWh annually), equivalent to the electricity use of 86–129 households.

The significance lies not only in the engineering savings but also in what the project represents. The PBC contracting process at HKUST can help to demonstrate how risks and responsibilities can be apportioned between client and the ESCO. This experience will help show owners how to draft the contract, how savings are verified, how performance is monitored, and how long-term adjustments can be handled. For EMSD, the LSK project can serve as a reference case when preparing model PBC documentation and guidance for the wider market.

By retrofitting a newer, well-managed facility, HKUST also addresses a common market question: are retrofits worth doing when a building already performs relatively efficiently? Incremental gains in such buildings may be smaller than in older stock, but they could still be financially and environmentally significant, especially for owners who want to demonstrate progress towards their own decarbonisation targets. For HKUST, this aligns with its aggressive campus commitment to reach net-zero by 2045, and the case is equally relevant for other institutions and companies seeking to showcase their climate ambition.

Moreover, HKUST engineers estimate that Hong Kong has over 200 comparable post-2010 ECBs, representing a combined floor area of about 5.3 million m^2. If PBC-style retrofits could say deliver savings of 15%, the result would be ~150 GWh per year in electricity reductions citywide or about 45,500 local households.

BOX 23
The Usefulness of Digital Twinning

As noted in Chapter 6, to strengthen confidence in retrofit outcomes, HKUST has developed a campus-wide DT platform that integrates BIM, real-time sensor data, and simulations across more than 60 buildings and 20,000 rooms. Together with HKUST's DSS, the DT provides a transferable evidence base linking retrofit design with verifiable performance data.

A pilot at the HKUST Library – an older building than LSK – used computational fluid dynamics and energy modelling to test retrofit scenarios. Results showed that replacing conventional glazing with low-e glass could cut HVAC energy use by 34.5% and total electricity consumption by about 14%, while improving thermal comfort and IAQ. These validated outcomes reduce uncertainty and give financiers and building owners stronger confidence in projected savings.

The DT platform thus complements PBC: PBC supplies the financing mechanism, while DT supplies the performance proof. This pairing not only supports HKUST's own decarbonisation goals but also offers Hong Kong a scalable model for mainstreaming retrofits, where trust in outcomes remains the critical missing link.

B: DIOCESAN GIRLS' SCHOOL (DGS)

DGS is one of Hong Kong's leading secondary schools, serves as an illustrative example of how energy-saving retrofits can be successfully integrated into major campus redevelopment and renewal efforts. Rather than pursuing retrofits as standalone engineering exercises, DGS approached energy and environmental performance as a cross-cutting priority embedded in broader infrastructure planning. The details below represent what DGS is considering to do with in the coming year.

Thirteen years ago, during the redevelopment of its school campus, DGS implemented a range of energy-saving interventions. These included energy efficient air-conditioning systems and environmentally friendly chillers; energy efficient lighting across classrooms and circulation areas; and sensor operated devices. Design features that maximize natural lighting and ventilation, along with the integration of green roofs and sustainable landscaping were also incorporated. Subsequent to the redevelopment, further initiatives including optimizing the efficient use of chillers and HVAC equipment through behavioural engineering; upgrading air conditioners to Class 1 Energy Level; adopting LED lighting extensively and installing solar panels have also been implemented. These measures were selected not only for their carbon-reduction potential, but also to enhance the learning environment and promote sustainability education among students. Looking ahead, DGS plans to invest in energy monitoring system and retrofit its campus using the EPC model, targeting to achieve energy saving in the region of 25% to 30% across the school footprint, thereby delivering electricity savings of 0.7 million kWh annually. Additional maintenance savings are expected to be realized through reduced servicing needs for lighting and HVAC systems.

Strategically, DGS's approach highlights how bundling retrofit measures with capital works projects can reduce marginal costs, align energy upgrades with structural improvements, and avoid duplicated work. The school leveraged a mix of public and philanthropic funding, demonstrating that energy retrofits in public-sector institutions can be made economically viable when timed alongside major facility upgrades. Equally important, the school's planned investment in energy monitoring systems has an educational function. Students can access real-time consumption data and apply it in classroom learning, reinforcing environmental awareness and literacy.

Under the EPC model, the contractor would finance the upfront costs, while the school would repay part of the expense in instalments, thereby reducing both initial and total capital outlay. The chosen ESCO would have to guarantee annual savings of 0.35 million kWh – equivalent to about HK$505,000 per year, or HK$5.05 million over 10 years. Any savings above the target would accrue to the ESCO, creating incentives for out-performance. The ESCO would also have to provide a state-of-the-art maintenance and optimization services to sustain peak performance. With projected savings of up to 0.7 million kWh annually, the reduction is equivalent to powering roughly 210 Hong Kong households (based on average consumption of 275 kWh per month per household).

The DGS experience shows how retrofitting in the education sector can be made more feasible when integrated into larger renovation efforts. Schools, universities, and other public institutions are uniquely positioned to serve as demonstration sites, achieving tangible energy savings, fostering sustainability education, and signalling civic leadership. This example underscores the value of prioritizing public-sector retrofits within a citywide decarbonization strategy.

C: ASIA SOCIETY HONG KONG

The Asia Society Hong Kong Center (ASHK) provides a distinctive example of how the complexity of building types and usage patterns can shape retrofit and EPC outcomes. Located within a heritage site, the campus combines both new and restored structures, including a major event hall, a small exhibition gallery, a theatre, and a number of smaller rooms that form part of the historic compound. The diversity of these spaces results in highly uneven patterns of energy use: while some facilities operate intensively during major programs, other spaces may be used only intermittently. Consequently, electricity consumption across the site fluctuates substantially depending on programming schedules, making the prediction of baseline consumption and savings more difficult than in more standardized office or commercial settings.

In 2018, ASHK became one of the earlier adopters of an EPC arrangement in Hong Kong. While the contract was intended to provide performance guarantees and a pathway for investment recovery, the experience highlighted the importance of clarity in contract design. Key terms between the client and the ESCO were not sufficiently detailed, leading to uncertainties and questions that emerged during the implementation phase. The situation was further complicated by the COVID-19 pandemic from 2020 to 2023, when the ASHK's activities were very drastically reduced. The pandemic represented an external shock that neither party had anticipated, further affecting the project terms.

The ASHK's case illustrates the challenges that EPC arrangements could face. It underscores the need for more carefully tailored contracts that reflect diverse building functions, variable demand patterns, proof of energy usage and savings, and the potential for unforeseen disruptions.

D: SHUI ON CENTRE – CAAS UNDER A BOOT MODEL

Shui On Centre, a 34-storey Grade A office tower in Wan Chai with a gross floor area of 51,500 m^2, became Hong Kong's first Cooling-as-a-Service (CaaS) project in 2023 under a BOOT model. The owner partnered with an ESCO to replace its ageing seawater-cooled chiller plant with a new AI-optimised freshwater-cooled system.

Under the 15-year contract, the ESCO financed, designed, built, and now operates and maintains the new system, which has a maximum cooling capacity of 2,100 refrigeration tonnes. The upgrade is expected to reduce electricity consumption by more than 30% on the chiller system, avoiding about 370 tonnes of CO_2 emissions annually.

For the client, the BOOT arrangement removed the need for upfront capital expenditure and shifted operating risks to the ESCO. Instead of bearing uncertain repair and energy costs, Shui On Centre pays a fixed monthly subscription fee that covers the system's full life-cycle management. Performance is guaranteed through annual system efficiency targets, measured by the COP, ensuring predictable energy use and eliminating unforeseen operating costs. For the ESCO, the model generates a stable long-term service revenue stream tied to verified efficiency outcomes. Tenants also benefit from consistent, reliable cooling.

The case demonstrates how BOOT/CaaS arrangements can unlock major retrofits by combining zero-capex solutions for owners with performance-based guarantees for financiers and service providers.

E: NINA TOWER – CAAS UNDER A BOOT MODEL

Nina Tower, one of the tallest mixed-use complexes in the New Territories with 180,000 m^2 of hotel, office, retail, and cultural space in 2023 by deploying the city's first zero-carbon chiller system through a BOOT contract for chiller plant replacement. The owner, Chinachem Group, entered a 20-year partnership with an ESCO to replace an ageing large-scale air-cooled chiller system with an energy-efficient fresh water-cooled chiller plants.

Under the agreement, the ESCO financed, designed, and engineered the system and now operates and maintains it on-site around the clock. Performance is guaranteed using annual system COP as the benchmark, with incentive and compensation mechanisms triggered at agreed efficiency thresholds.

This arrangement reduces reliance on complex long-term measurement of baselines while still ensuring accountability.

The BOOT model eliminated the owner's upfront capital outlay and transferred chiller plants operational responsibility to the ESCO. Chinachem pays a predictable monthly service fee that includes full life-cycle management and performance assurance.

The new chiller plants are expected to cut electricity use by over 40% compared with the old system, avoiding about 7,000 tonnes of CO_2 annually. To ensure zero-carbon operation, the electricity consumed is matched by Green Electricity Certificates linked to a single-sourced renewable project from the ESCO.[65] This makes Nina Tower the first large-scale chiller system in Hong Kong to operate on fully zero-carbon electricity.

The case illustrates how BOOT/CaaS models can deliver both deep efficiency gains and innovative zero-carbon solutions at scale, while providing building owners with predictable costs.

F: PUBLIC SECTOR POTENTIALS

The Hong Kong public sector oversees a vast and ageing building stock, often cited as comprising more than 8,000 government-owned buildings and facilities. This figure, however, is venue-based rather than building-based. For example, a single government office building housing five departments may be counted as five facilities. Regardless of the counting method, much of this stock is over 50 years old, with outdated systems and sub-optimal energy performance. Tackling energy use in public buildings is therefore central to meeting Hong Kong's 2035 decarbonisation goals from buildings and moving towards full carbon neutrality by 2050, while also reducing operating costs and easing the long-term fiscal burden on government.

A new idea is to link public sector retrofitting with carbon credit generation. The idea is to develop an ecosystem in which emissions reductions from retrofit projects can be monetised through the issuance and sale of carbon credits. This would create a new incentive for public agencies such as the Housing Authority, Housing Society, Urban Renewal Authority and West Kowloon Cultural District to prioritise and finance retrofits.

The framework works as follows: suitable public buildings are first identified for decarbonisation based on age, use type, and potential for savings. Energy and carbon reductions from retrofit interventions are estimated and modelled. These projected credits are then matched with potential buyers via offtake agreements, forming the basis to raise finance for implementation. After the retrofit is completed, verified, and registered, carbon credits are transferred to buyers, allowing agencies to recover costs and potentially reinvest proceeds into future projects.

This model addresses two long-standing barriers: the high upfront capex associated with public sector retrofits, and the lack of ongoing financial incentives for government departments to prioritise energy upgrades. By monetising the carbon value of retrofits, the model introduces a new stream of blended finance and strengthens the business case for action.

Strategically, this approach could show how carbon finance can be used not just for headline infrastructure, but for deep, scalable decarbonisation across government portfolios. The proposed system would also position Hong Kong as a regional leader in applying green finance tools, creating local demand for carbon verification services, project design expertise, and monitoring platforms. It also reinforces the public sector's role as a market leader, signalling new performance expectations to the private sector.

Beyond emissions reductions, public retrofits offer important co-benefits: enhanced indoor air quality, better thermal comfort in schools, hospitals and public housing, job creation in retrofitting trades, and strengthened community trust in government-led climate action. When linked with education, health, and social service outcomes, the retrofit agenda becomes a platform for integrated policy delivery.

There are potentials for public sector agencies to move from incremental to programmatic action by using carbon credit frameworks to unlock finance, aggregate projects, and lead the energy transition from the front. It is a model that could be scaled not only within Hong Kong but across other Asian cities facing similar retrofit challenges.

The Shui On Centre cases demonstrate that PBC variants are no longer just conceptual options discussed in policy reports but are already being deployed in Hong Kong's commercial sector. Together with earlier examples from universities, schools, and non-profits, they show that PBC and its variants form a practical, adaptable toolkit for retrofitting across different building types and ownership models. Embedding these approaches into Hong Kong's wider *Retrofit Finance Platform* would help move them from isolated pilots into mainstream market practice.

63. World Green Building Council. (2025). B*uilding transition: Financing market transformation*. https://worldgbc.org/building-the-transition/.

64. The Chief Executive's Policy Address 2025, para 235, https://www.policyaddress.gov.hk/2025/en/.

65. The Green Electricity Certificates in this case are linked to renewable energy generated by a CLP Holding's project. Under the BOOT agreement, the electricity consumed by the chiller plant is matched on a 1:1 basis with the Green Electricity Certificates, making the system ef

SUSTAINING RETROFIT PERFORMANCE – THE ROLE OF BUILDING MANAGEMENT

One of the underappreciated challenges in the building retrofit market is what happens after a project is completed. While energy savings may be achieved in the immediate post-retrofit period, performance often drifts downward over time. This so-called 'post-retrofit performance gap' is not caused by flaws in technology or poor ESCO execution, but by insufficient operational follow-through by the building's own facilities management team.

This pattern is well documented internationally. A study by International Energy Agency (IEA) in 2022[66] identified significant drop-offs in energy performance within two to five years of retrofit completion, often due to the inability of in-house staff to adjust system settings, schedules, or controls to match occupancy patterns or seasonal variations. In some cases, energy-saving systems were overridden or disabled entirely due to a lack of understanding of how they work.

Beyond sustaining performance after retrofits, facilities management (FM) companies could also play a proactive role in initiating projects. For the large share of buildings not owned by major developers, FMs often act as the de facto technical advisers to owners. They are well positioned to monitor plant efficiency, identify retrofit opportunities, and guide owners through funding options such as utility subsidies, government schemes, or green finance. By preparing preliminary assessments, coordinating tendering processes, and comparing PBC proposals, FM companies can reduce transaction complexity and provide owners with a "trouble-free" pathway to decision-making. Realising this potential will require targeted training and accreditation so that FMs can combine their traditional operational duties with retrofit advisory capabilities, creating new revenue streams through project management fees while building long-term client loyalty.

Yet, in practice, when FMs lack the skills or resources to fulfil this proactive role, performance risks persist. One recurring issue is tension between ESCOs and building owners under PBC contracts. ESCOs are contractually bound to deliver savings, often measured through rigorous M&V protocols. If savings fall short, disputes can arise over whether the ESCO failed to meet technical guarantees or whether the owner's operational team failed to maintain required performance standards. To reduce such conflicts, many ESCOs have begun to offer post-retrofit service agreements that extend beyond handover, enabling them to monitor performance and troubleshoot in real time.

The underlying challenge is that many building management professionals, particularly in older buildings or smaller portfolios, still lack the technical expertise to operate high-efficiency, sensor-enabled, and digitally controlled systems. HVAC systems, BMS platforms, and energy dashboards now require not just mechanical understanding but also data literacy. Yet many facilities teams have not received adequate training on how to interpret CO_2 sensors, occupancy-based controls, or how to optimize IAQ while maintaining energy efficiency.

This has broader implications. As the retrofit market grows, so too does the need for a new generation of digitally capable, sustainability-aware building operators. Buildings must now be operated not just for tenant comfort but also for carbon performance, compliance, and resilience. Owners, tenants, and financiers all have an interest in ensuring that performance is sustained, not only to protect investments but to maintain asset value and ESG credibility.

This creates an opportunity for public-private collaboration. The HKSAR Government, working with industry associations such as HKGBC and professional bodies, could help design and roll out a capacity-building framework for the building management sector. Key measures could include:

- Accredited training programs focused on energy-smart operations, digital controls, and IAQ optimization.
- Industry-recognised certifications for energy-literate facilities managers and operations teams.

- Integration of operational support into standard PBC templates, including remote monitoring, quarterly tuning, or continuous commissioning.
- Incentives for buildings that maintain performance over time, such as reduced property rates or access to public sector retrofit tenders.

Similar approaches are already being trialled in Singapore, the EU, and the U.S., where public agencies co-sponsor post-retrofit operational support and upskilling programs. In Hong Kong, this model could address a persistent barrier to retrofit success while improving career pathways for building operators.

Ultimately, ensuring that retrofitted buildings perform as intended is not just a technical issue, it is a people issue. By supporting building managers with the right training and institutional backing, Hong Kong can unlock a new phase of retrofit impact, one where gains are not only achieved, but sustained.

66. International Energy Agency. (2022). *The value of building energy efficiency: Unlocking the climate and economic benefits.* https://www.iea.org/reports/the-value-of-building-energy-efficiency.

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