1 Retrofitting and Green Buildings

1.1 Research Overview

In 2017, the *13th Five-Year Plan for the Development of the Construction Industry* issued by the Ministry of Housing and Urban-Rural Development recognises the critical role green buildings play in developing cleaner and smarter cities in China. The plan provides a view of China's current priorities:

- Improve building energy saving levels through the development of green building techniques, such as use of green materials.
- Promote energy-efficient building technologies and promote renewable energy research for new building materials and wall insulation, doors and windows.
- Promote green building standards through new/improved standards, norms and evaluation systems covering design, construction and operation.[1]

Market direction has also been provided by the Ministry of Housing and Urban-Rural Development who were joined by seven other government departments to jointly issue an action plan for green building construction. By 2022, up to 70 percent of all new buildings in cities and towns in designated green building areas should be green buildings, certification levels for green buildings based on the Chinese Green Building Evaluation Label should continue to increase, energy efficiency in buildings should also increase, along with improvements in residential health. The proportion of prefabricated construction should increase, use of green building materials should expand, and public knowledge and acceptance of 'green buildings' should also increase.[2]

According to the *13th Five-Year Plan for the Development of the Construction Industry* by 2020, green construction areas should account for more than 50 percent of new urban buildings and 40 percent of building materials should be 'green'.[3] Beijing for example, announced that by the end of 2020, the designated green building area should have accounted for more than 25 percent of the total urban civilian building area and 40 percent of all materials in new buildings should have been 'green'.[4]

By the end of 2018, there were 13,000 'green building' construction projects in China with a total floor area of more than 1.4 billion square meters. The total green building area in China's cities and towns exceeded 3.2 billion square meters. In 2018, green buildings accounted for 56 percent of new civil buildings in cities and towns. By the end of October 2019, a total of 66.238 million square meters of public buildings in key cities had been renovated to conserve energy, bringing the total area of public buildings renovated to over 210 million square meters nationwide.[5]

By the end of 2018, photovoltaic renewable energy installed in buildings provided energy for an area of 5.876 billion square meters and about 70 million tons of standard coal had been displaced annually (equivalent to 7.5 percent of total building energy consumption).[5]

Since the announcement of the Five Year Plan, nearly 20 cities have set more ambitious targets than national requirements. For example, Changde, Zhenjiang, Zibo, Wuxi, and Suzhou, Shanghai, Beijing, Shenzhen, and Chongqing will require all new commercial buildings to be 'green buildings'.[6]

Based on policy trends and market research we have identified the following specific supply chain gaps: Knowledge gaps; Building materials and technologies; and, Retrofitting with energy saving materials.

1.2 Knowledge gaps

In China, there is often insufficient incentives for developers to invest to help save energy. Moreover, it is hard to benchmark building performance as data is not stored, incomplete or inaccurate. In addition, Chinese developers typically prioritise short-term costs and benefits and perceive the payback of 'green' investment is too long. These issues arise because of a lack of information and a conservative approach to development. Consequently, it presents a challenge for the further long-term scaling of green building concepts and investment.[7]

1.3 Building materials and technologies

Multinational companies, larger Chinese developers, and an increasing number of hotels and resorts are the most likely to adopt green technologies. A large majority of these projects will involve architectural and design teams from overseas and utilise international building certifications, such as the US Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED).[12]

Although 13th Five Year Plan gave significant recognition to green buildings and kick-started its development, green buildings in China still lack important fundamentals. According to *A Review Of Green Building Development in China,* Chinese green buildings have not yet met expectations, supported green technology concepts or promoted consumer demands.[8] Some of these issues contribute to a preference for imported goods and materials. Similarly, consumers are willing to purchase imported goods and materials where there is a technology, quality and green premium.[9]

A guidance document issues by the United States International Trade Administration, "Construction and Green Building" report released in 2017 provided details on China's top green construction materials imported from the US. The reported disclosed that the following materials were highly sought out to fulfil China's demands in green materials[13]:

"Glass, waterproof materials, indoor decorations and fixtures (gypsum plaster boards and suspended ceilings), advanced ceramics (divided into electronic, micro-crystalline and Nano-ceramics, advanced ceramic matrix composites being the best-selling advanced ceramics product) and wood."[13]

1.4 Retrofitting with energy saving products

According to the China Energy Conservation Association's (EMCA) Energy Savings Company (ESCO) Committee, due to low investment costs and rapid payback, waste heat and pressure utilisation projects, motor system energy conservation projects and energy system optimisation engineering are the most common project types.[11] 75 percent of these projects have a payback of less than five years. 71 percent of Energy Performance Contracting (EPC) projects have less than three year payback.[11]

1.5 Addressing the Gaps

We have identified the following UK companies that can help address the supply chain gaps identified above. Information in this table draws upon publically available information from each of the companies listed. It does not reflect the opinion of the PDP. The PDP does not attest to its accuracy.

#	Company Name	Company Description	Location of HQ	Relevance	Main Corresponding Gap
1	IES	Deploys integrated building performance modelling technology.	Glasgow	• Predictive Design for Performance Contracting • Simulation for SMART Buildings and Deep Retrofit • 3D Calibrated Simulations • Retrofit for the Manufacturing Environment: Process Integrated Building Modelling Integrated analysis of buildings on energy conservation • Undertake sustainable master planning • Delve into zero-carbon construction/retrofitting of individual buildings • Operate buildings or communities more effectively • Integrate with utilities and renewables to create local energy networks	• Building technologies
2	Qbots	Artificial Intelligence based model that provides analysis and provides options on power reduction and energy optimisation.	Manchester	• Peak power reduction and energy optimisation for buildings • Analyses of real-time energy supply costs and reacts to the trading opportunities by utilising local assets to minimise cost and maximise revenue • Energy consumption analysis and energy management consultation • Automated system matching prosumers with similar preferences including environmental, risks, community interests, location, time etc. • Facilitates the participation of groups of prosumers in wholesale electricity markets, including ancillary services	• Building technologies • Knowledge gaps

				• Peer-to-peer energy-trading platform with transactions between self-organizing prosumers	
3	Blockdox	BlockDox uses IoT sensors and artificial intelligence to count people, analyse people flow in real time, and measure indoor environmental conditions.	London	• Big data analysis of office buildings • Optimize the use of buildings and office environment • Retrofitting and transforming buildings into smart buildings	• Building technologies • Knowledge gaps
	AESG	Consulting company with energy and sustainable development, environment and waste capabilities.	London	• Sustainability Consultancy (LEED, Estidama, WELL and Net Zero) • Facility Management • Waste Management • Thermal insulation planning • Sustainable Design, environmental assessment, carbon strategies	• Knowledge gaps
5	Arup	Works with clients to deliver award-winning buildings, often recognised for their sustainable credentials.	Sheffield	• Structure and façade investigations, material testing, appraisals, structural and seismic retrofit and alterations, vibration analysis and remediation, reviews and improvements to acoustic performance • Assessments and upgrading building services, energy efficiency, service life prediction, return on investment studies, MEP system condition surveys, building physics upgrade, smoke modelling, CFD analysis, fire safety evaluations and system design • Pedestrian flow modelling, 3D scanning and BIM modelling of existing spaces • Building maintenance and facilities management, technical due diligence (TDD and EDD), portfolio analysis of building performance and efficiency • Highly qualified and certified in sustainable building retrofitting & designing	• Knowledge gaps
6	BRE Group	Products, services, standards and qualifications on sustainability.	Dublin	• Green standards development, certification, training, and integration of green building industry chain suppliers	• Knowledge gaps

				• Energy advisory, from strategic and commercial support, and carbon and energy management programmes, to regulatory and policy guidance.	
7	BSI	BSI produces technical standards on a wide range of products and services and also supplies certification and standards-related services to businesses.	London	• ISO/sustainability standards & certification • Standards products	• Knowledge gaps
8	Vestemi	Radbot, smart thermostatic radiator valve that uses zoning and occupancy sensing to ensure the spaces people occupy are only heated when required. Results in heat energy savings estimated at 30% and an ROI of around one year	London	• Smart radiator thermostat that monitors the occupancy pattern of a room and automatically adjusts the heating pattern, so it only heats the room when someone is there. • Simple to install and use. It requires no Wi-Fi, no 4G, no mobile phone app and no requirement to program complex heating schedules.	• Retrofitting with energy saving products
9	ICAX	Thermal Banks to store heat energy collected in the summer for use in winter to heat buildings.	London	• Renewable Heat & cooling technologies • Air source heat pumps • Thermal banks • Heat pumps • Thermal modelling • Water source heat pumps • Marine source heat pumps • Energy storage	• Retrofitting with energy saving products
10	EPS (Environmental Process Systems LTD)	Refrigeration and HVAC technologies.	Peterborough	• Products to reduce Energy Consumption and offer Environmentally Acceptable Alternative Solutions • Wide range of products focused on cooling • PCM	• Retrofitting with energy saving products
11	Q-bot	Deploys robotic and AI systems to construct, maintain and upgrade buildings for energy-efficiency.	London	• Using robotics to reduce the need for energy • Using digital infrastructure and 3D Scanning systems to monitor a building's condition and needs, can be used to reduce energy usage, reduce cost of maintenance, planned upgrades and asset management	• Retrofitting with energy saving products

				• Using robotics for the insulation and finishing off walls, facades and other structures on site, to reduce the need for scaffolding when retrofitting	
12	Enviroheat	Efficient heating and hot water systems.	Greater Manchester	• Smart heating system (EconoRad) • Energy efficient hot water cylinder (EconoCyinder) • Products reduces energy consumption, energy costs and it's easy to install	• Retrofitting with energy saving products
13	Kast Energy Solutions	Solar PV, Voltage Optimisation, De-Stratification fans, Low Energy Lighting, Infra Red Heating, Energy Monitoring and Electric Vehicle Charging Point installation.	Bredbury	• Air source heat pumps (Approved for UK RHI Scheme) • Destratification Fans	• Retrofitting with energy saving products
14	Incube	Modular walls and sustainable office design.	London	• Intelligent equipment and platform are used to carry out decoration design and space optimisation design in the building, mainly office projects, without Chinese projects • Modular Walls • Allows for convenience in controlling office spaces through IoT dashboards to maximize value and efficiency	• Retrofitting with energy saving products
15	ZEDfactory	Low carbon building and development technologies.	Wallington	• Solar photovoltaic roofing system • Solar-charged exchangeable batteries • Space & energy optimized buildings & houses • E-bike & E-bike charging & locking dock	• Retrofitting with energy saving products
16	Eco Home Upgrades Ltd	A Low Carbon Retrofitting Service For Domestic Homes And Installers Of Eco Energy Home Measures. Products include Thermostatic radiator valve, hot water cylinder units, eco lightning products and eco shower heads etc.	Manchester	• Thermostatic Radiator Valve • Radiator Backboards • Hot water cylinder units • Pressure Reducing Valve • Eco lightning products • Eco Shower head • Products improve efficiency and reduces energy consumption	• Retrofitting with energy saving products

17	Evergreen Energy	Sustainable and efficient products such as heat pumps, solar panels, underfloor heating systems and energy efficient radiators.	Salford	• Heat pump • Solar panels • Solar thermal panels • Underfloor heating systems • Energy-efficient radiators • Eco friendly products that improves efficiency	• Retrofitting with energy saving products
18	Solarcrest Distribution Ltd	Sustainable insulation & ventilation.	Manchester	• Neutral Plus Glazing (eliminate internal condensation, reducing draughts and cold spots in and around the windows) • Low energy LED lightning • Microgeneration products	• Retrofitting with energy saving products
19	Polysolar Commercial	Developer and manufacturer of transparent thin-film photovoltaic glazing for building integrated applications (BIPV).	Cambridge	• Manufactures and produces solar glass that generates renewable energy • Supplies solar glass and installation services	• Retrofitting with energy saving products
20	Datum Phase Change Ltd	ThermaCool® wall and ceiling products. For use in both new build construction and retrofit of commercial and residential buildings. ThermaCool® products reduce the energy consumption of climate control systems.	Essex	• Using PCMs to regulate the temperature of a building • Products: ThermaHeat, ThermaCool Panel ThermaCool Tile • ThermaHeat® systems provide a low energy radiant heating solution using far-infrared heating which is a natural and healthy radiant heat • ThermaCool® panel incorporates phase change material to provide a complete construction board for light weight systems that absorb, store and release excess latent heat from within the building	• Retrofitting with energy saving products
21	Ventive	Designs naturally intelligent ventilation systems to deliver fresh air efficiently.	London	• Design service of intelligent ventilation systems to deliver fresh air at low cost • Smart ventilation products	• Retrofitting with energy saving products
22	PurrMetrix	Sensors to measure the temperature across a whole building, at a fine level of detail. This data is sent back to a web application where it is mapped onto a	Great Shelford	• Smart temperature sensors • Every 30 seconds data is sent back, via a gateway, to the users web account, which uses state of the art analytics to create actionable insights.	• Retrofitting with energy saving products

		plan of the building, and used to create some analysis.			
23	AirDri Ltd	Sustainable hand dyers.	Oxford	• Low energy consumption hand dryers • Airdri quantum runs at 0.2KW, grouping it as a low energy consumption hand dryer	• Retrofitting with energy saving products
24	The Wee House Co.	Supplies modular homes to housing associations and housing developers across the UK.	East Ayrshire	• Supplier and manufacturer of Modular homes • Houses are built using modular construction method	• Others

Contact details of the above UK companies can be provided after the consent forms are completed by the UK companies. The approval of the consent form template by the Authority is currently pending.