



AI in the Built World

a/c proptech



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Foreword

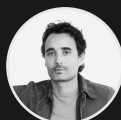
It can pass exams with (almost) flying colours and write lines of code from scratch. Open AI's ChatGPT and the potential of generative AI more broadly has been dominating the conversation in the tech and venture circles as of late. Its latest version, ChatGPT-4, which was released on March 14, is truly astonishing considering we are only in the very early innings of the AI disruption, with a new world of possibilities across all industries.

Artificial intelligence could and most likely will have many far reaching applications that will transform a number of industries, and in particular in these early days, those where rapid recall and manipulation of text and images sits at the core. However, there will be many other applications that will begin to emerge as AI finds its way into various aspects of our daily lives and eventually changes the way we all work, learn, and communicate with each other.

In our latest report, AI in the Built World, we examine how AI has the potential to change the Built World and where we are already seeing it being used within various applications across the design, construction and operations of buildings. A/O invests in companies that enable and accelerate the positive transformation of our Built World. As this report will show, there are many ways in which the application of AI technology in the Built World can be an enabler and accelerator of progress on our path towards a net zero economy to avoid a climate disaster.

Our team's research sheds light on the various AI applications that are attracting investors' attention, the levels of capital flowing into the various subsets of the sector and in particular into companies which leverage AI in some capacity to deliver their product/service. While big tech will be the first to deploy generative AI tools at scale, we anticipate Built World incumbents and a host of new market entrants will rely on using a combination of AI technologies in their new normal course of business.

However, in order for AI to truly play a significant role in shaping our Built World, it will need to rely on a greater availability of useful data alongside other enabling technologies. It is the combination of all of those which together have the power to transform the industry for the better. For this reason, continued broad based investment in innovation is key to unlocking this new world of possibilities. We hope you enjoy learning more about all of the various technologies and companies pioneering our new world of Built World AI.



Gregory Dewerpe
Founder, CIO

Key Takeaways

By ChatGPT

- **An ecosystem of AI technologies are enabling the digitisation and decarbonisation of the Built World.** Startups are using a combination of AI technologies including robotics, IoT, natural language processing and generative models to solve for a diverse set of pain points across the built environment, from energy efficiency and climate risk to construction and real estate sales.
- **Venture investors are taking note.** Over the past ten years, AI-enabled Built World startups in Europe and North America have received a total of \$18.6B in venture funding, of which close to half was in the last two years (\$8.6B). And in both 2020 and 2022, venture deals in AI-enabled Built World startups overtook FinTech AI funding, reaching over 600 deals globally in 2021 alone.
- **London is the leading city for deal count**, while the Bay Area continues to attract the most capital. Over the past five years, London has consistently been the number one city by deal flow, ahead of San Francisco, New York and Paris, and the top European city for invested equity. In fact, more deals were done in London over the time period (2017-2022) than Paris, Berlin, Dublin and Tel Aviv combined. However, the Bay Area is the leader when it comes to invested capital, raising \$4.6B over the five year time period.
- **Climate technology is the fastest growing application of AI in the Built World.** Our analysis identifies Climate Risk, ESG Reporting + Compliance and Energy Assets as the three fastest growing applications of AI in the Built World. Other clear growth verticals include Architectural, Engineering and Construction (AEC) Software, Smart Cities, Smart Buildings and Real Estate Asset Inspection – areas where the majority of startups have a strong climate focus. Meanwhile the largest deals are concentrated in the Built World's most mature segments: Real Estate Transactions, Retail, Property + Tenant Management, and Construction.
- **Generative AI applications are emerging in the Built World**, but there's a long way to go. Applications are primarily concentrated in AEC Software, with features including 3D model creation from a 2D image, custom material render generation, optimised floor plan layouts, and even the generation of a Building Information Model from simple descriptive text. However, the industry's highly heterogeneous and context-specific nature of building-level data, coupled with the lack of readily available data, poses a challenge to generative AI's deployment. Despite the potential of generative models, digitisation and automation will be crucial in the short term.

A/O Research
produced using AI

Cover Page + Contents Page:

Midjourney artworks by Hassan Ragab

Summary Text: ChatGPT (with A/O edits)

Data Analysis: A/O pre-trained models and
natural language processing

Images: Midjourney

AI Ecosystem

The AI ecosystem comprises a host of technologies, from robotics and computer vision to natural language processing and generative models. With one in five venture-backed Built World companies leveraging some form of AI, the AI ecosystem serves as a powerful enabler for the digitisation and decarbonisation of the Built World.

AI is an Enabler of Built World Transformation

While smart building solutions, property + tenant management and climate risk startups commonly use AI to process data gathered by IoT sensors, real estate transaction startups often use AI to facilitate data analytics.

The greatest spread of different technologies can be seen in construction startups, where AI is employed across robotics, remote sensing, IoT, and computer vision.

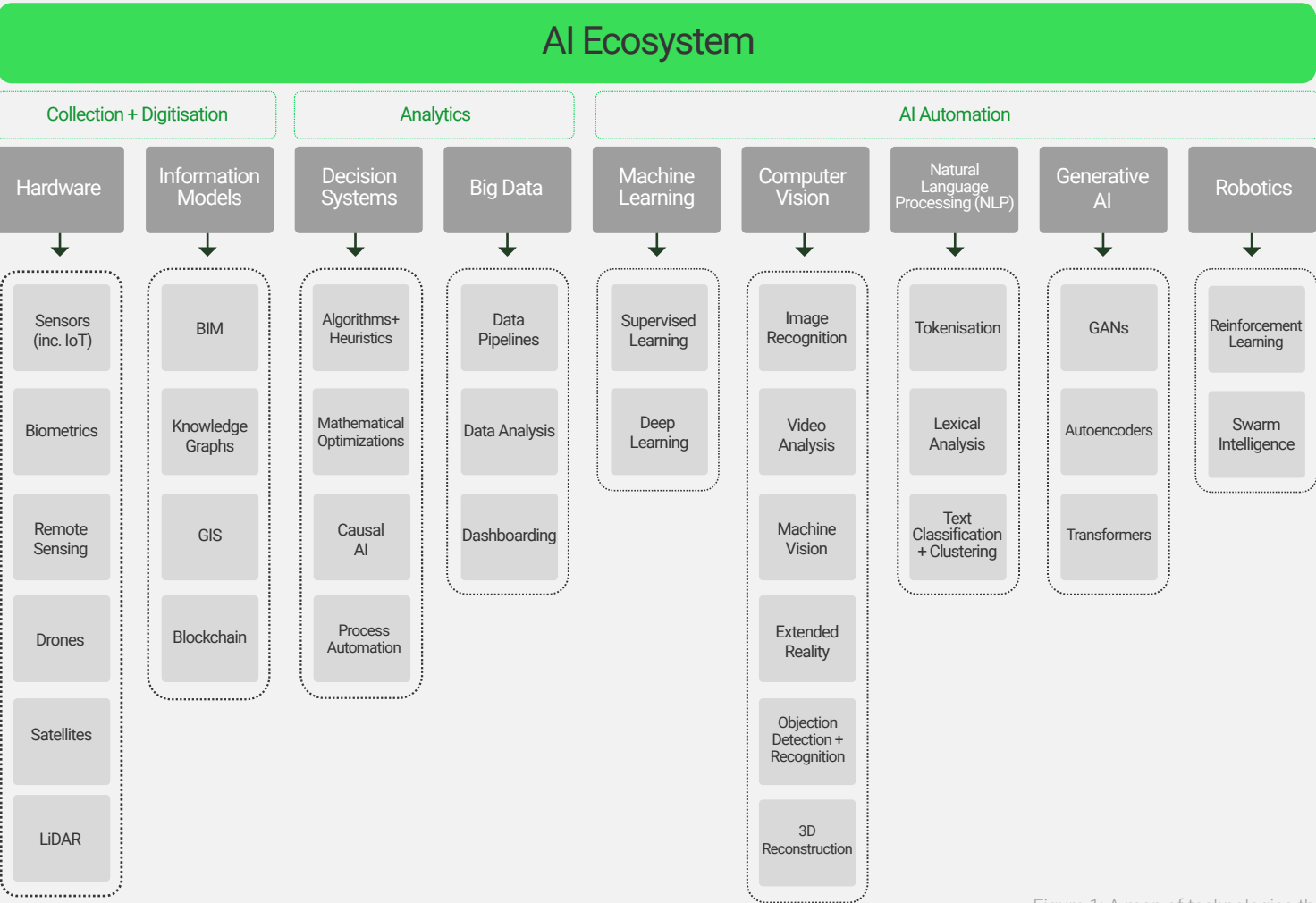


Figure 1: A map of technologies that sit within the AI ecosystem

Mapping AI Technologies to the Built World

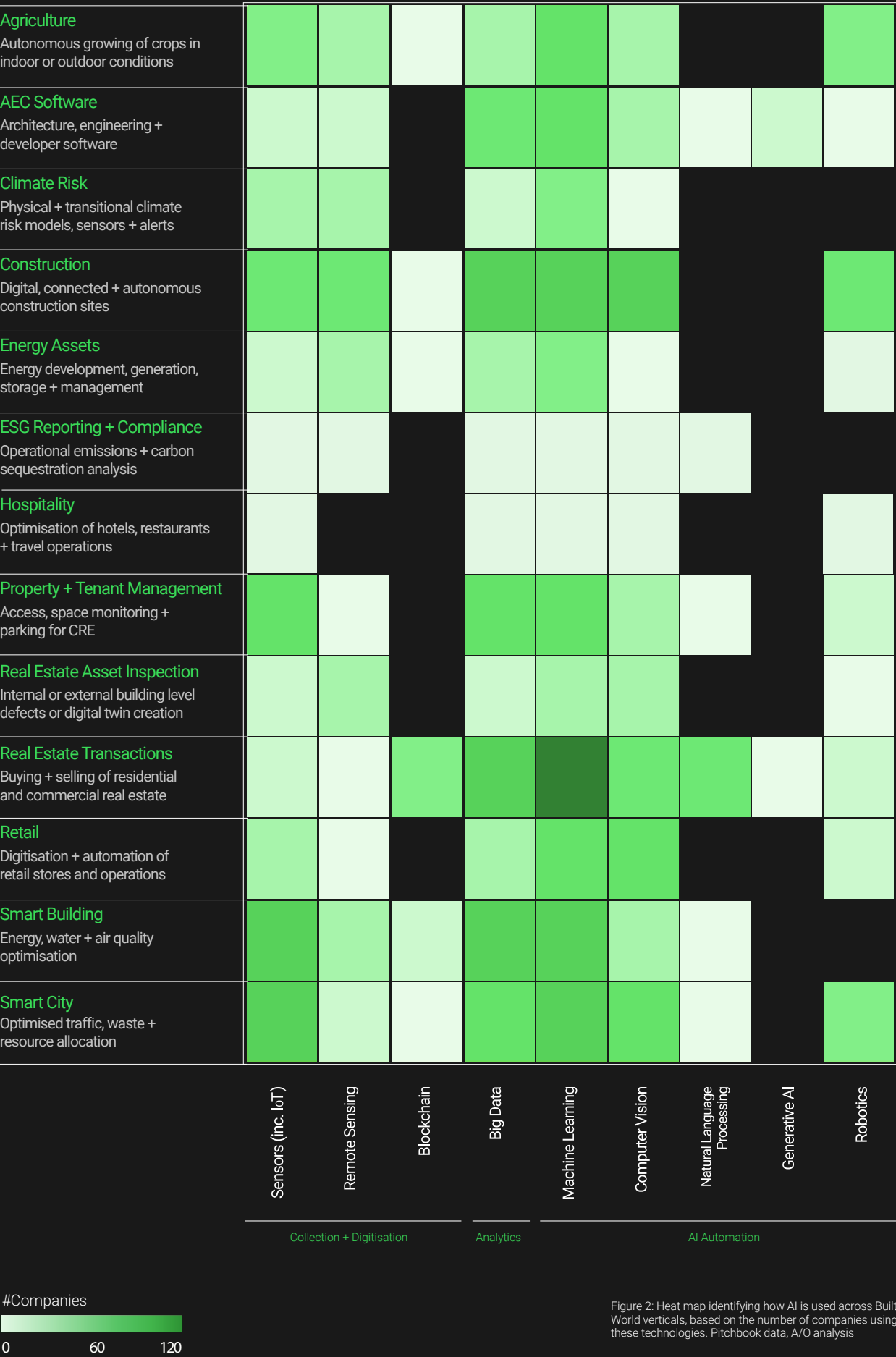


Figure 2: Heat map identifying how AI is used across Built World verticals, based on the number of companies using these technologies. Pitchbook data, A/O analysis

Applying AI to the Built World

Startups are leveraging a combination of AI technologies to solve for some of the Built World's greatest pain points.

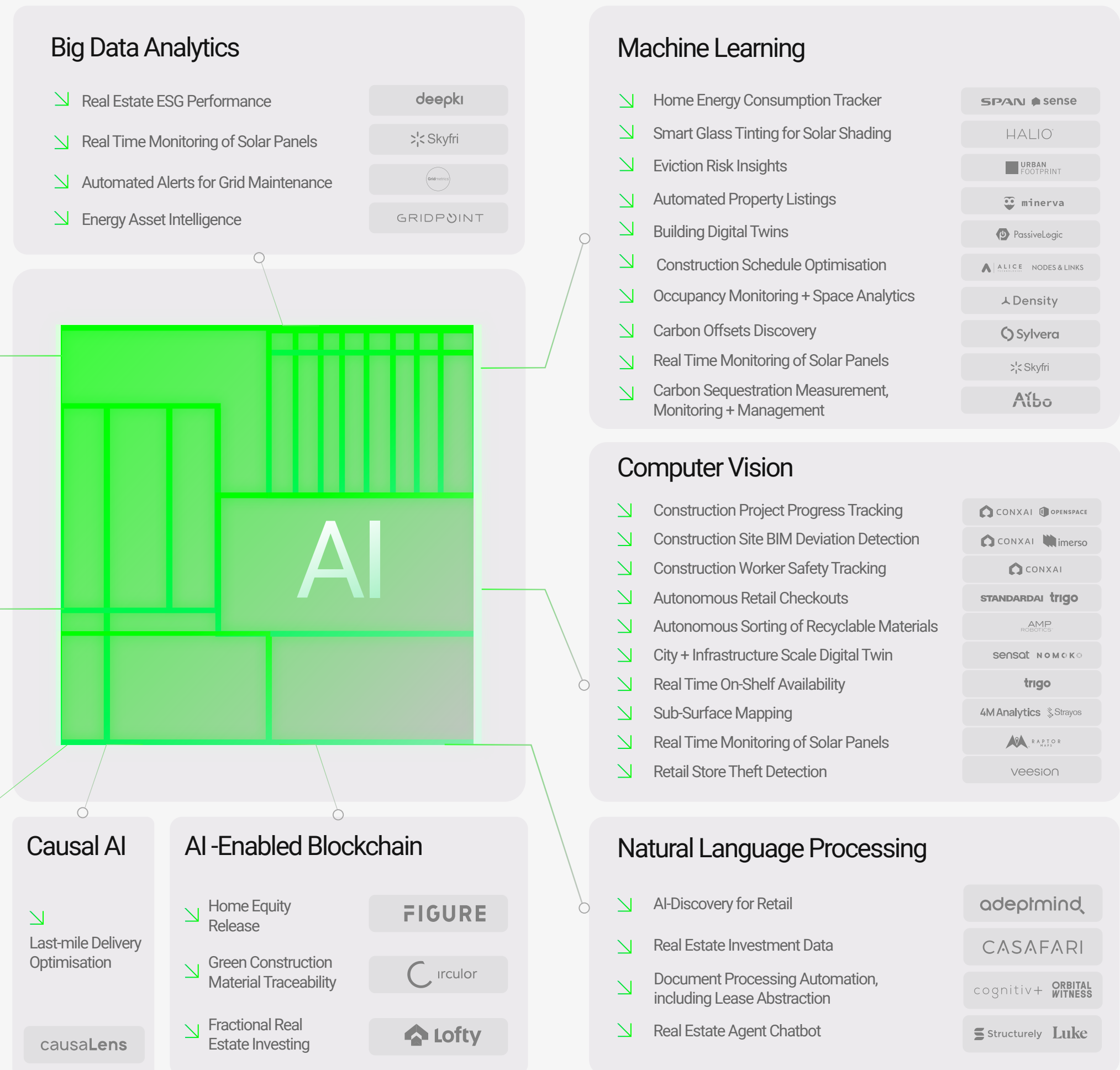


Figure 3: Matching AI technologies to Built World use cases

The Rise of Generative AI

In recent months, generative AI tools such as OpenAI's ChatGPT have exploded in use across a number of industries, including law, education and advertising + marketing.

Generative AI is also beginning to make its presence known in the Built World. Applications range from leveraging generalist solutions – such as chatbots to optimise property management, image generators (such as DALL-E and Midjourney) and enhancers (such as LetsEnhance and Oda Studio) to augment real estate sales and synthetic data generators (such as Mostly.AI, MindTech and LatticeFlow) to train AI models – through to specialist products tailored to Built World use cases.

When it comes to the latter, there are a growing number of pre-seed startups leveraging generative models to optimise building design. Though the technology is still in its infancy, the potential for future market development is notable.

Functions include instant 3D model creation from a 2D image, custom material render generation (such as Poly), optimised floor plan layouts (such as Maket), and even the generation of a Building Information Model (BIM) from simple descriptive text (such as Hypar).

Applications to building design are promising, yet there remains a long way to go before solutions can offer efficiency gains similar to that of which ChatGPT is currently enabling across other industries. This is because, unlike readily available image or text data, there is a shortage of building design and construction data.

Data shortages are only exacerbated by the highly heterogenous and context-specific nature of building-level data, which makes it much more difficult to collect a similar set of data.

For data types gathered at much larger scales - such as satellite imagery and GPS data – training datasets are large enough to harness the full power of generative models. This can be seen in solutions such as Blackshark.ai, which leverages generative models to create a digital twin of the earth.

While generative AI presents significant potential, in the short term digitisation and automation will be key – especially for the industry's most analogue aspects, such as construction materials procurement and in-person energy audits.

Startups such as Satellite Vu plan to collect the data that fills the gap between the high-fidelity drone or street level data and general large scale satellite mapping data. Satellite Vu's CTO Tobias Reinicke explains:

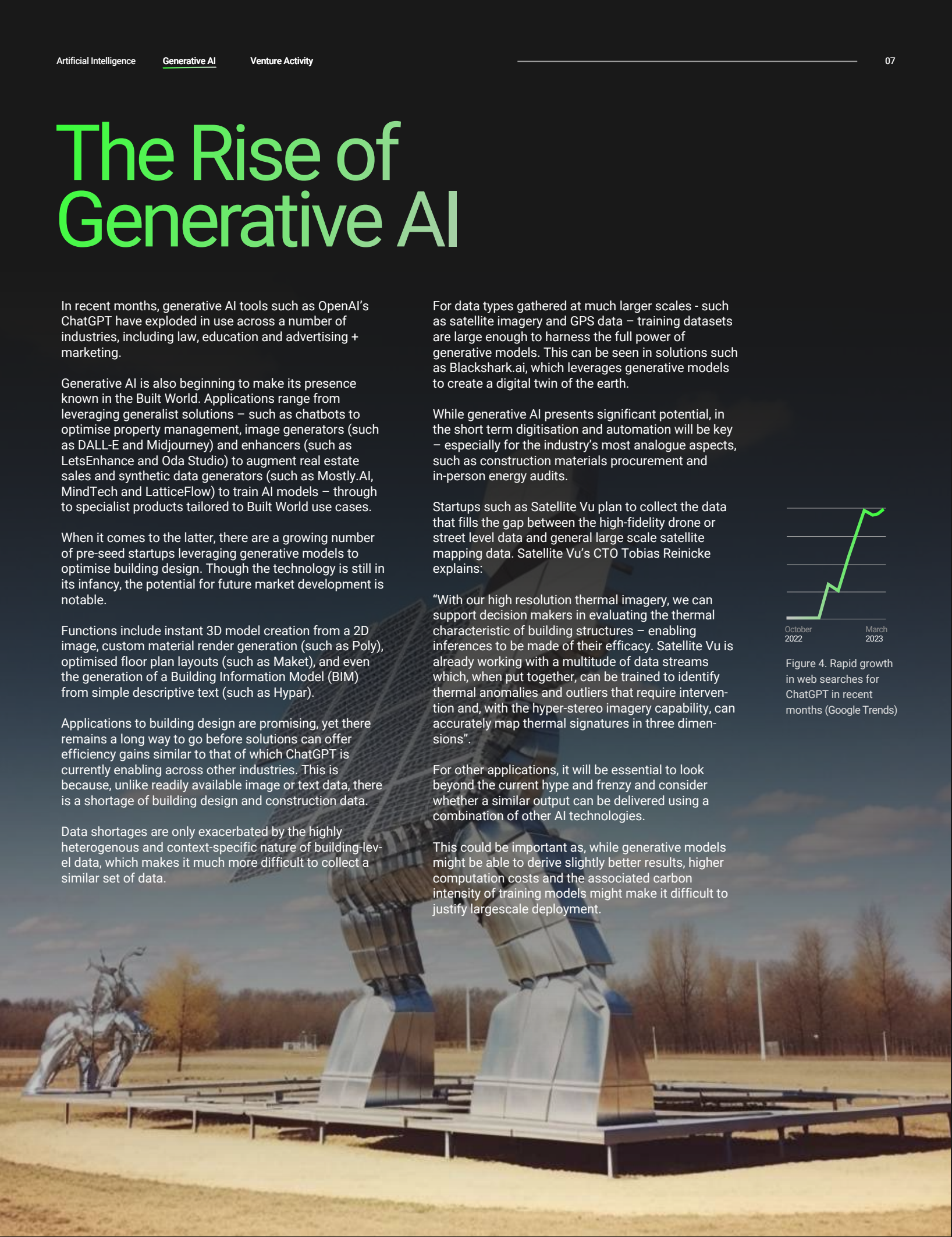
"With our high resolution thermal imagery, we can support decision makers in evaluating the thermal characteristic of building structures – enabling inferences to be made of their efficacy. Satellite Vu is already working with a multitude of data streams which, when put together, can be trained to identify thermal anomalies and outliers that require intervention and, with the hyper-stereo imagery capability, can accurately map thermal signatures in three dimensions".

For other applications, it will be essential to look beyond the current hype and frenzy and consider whether a similar output can be delivered using a combination of other AI technologies.

This could be important as, while generative models might be able to derive slightly better results, higher computation costs and the associated carbon intensity of training models might make it difficult to justify largescale deployment.



Figure 4. Rapid growth in web searches for ChatGPT in recent months (Google Trends)



Generative AI in the Built World

Part of the wider AI ecosystem, generative training models learn from large datasets to create new, similar data. Core applications of generative models in the Built World focus on generative adversarial networks (GANs), dense pre-trained networks (DPT) and auto encoders, which can be used to synthesise and augment data, as well as automate core aspects of design workflows. There are currently a handful of commercialised applications in the Built World, and we expect to see a number of new applications come to market in the coming years.

Data Synthesis

Generative model outputs data in a different format to the input, with the results able to be used either qualitatively or quantitatively for Built World workflows.



Map
conversion +
creation (GIS)



Climate data
estimation +
simulation*



3D reconstruction*



Environmental
performance
simulation



Cross view image
generation

Data Augmentation

Generative model outputs data in a similar format to the input data, but with improvements in resolution or completion.



Digital surface
model (DSM)
enhancement



Satellite image +
street view
enhancement



Data upsampling



Image enhancement
+ restoration



Discovery of low
carbon concrete
formulations

Design Automation

Generative model outputs data in a different format to the input, with results able to be used qualitatively to inspire or automate certain workflow processes.



3D model
generation



Design analysis,
assistance +
generation



Floor plan
generation +
optimisation*



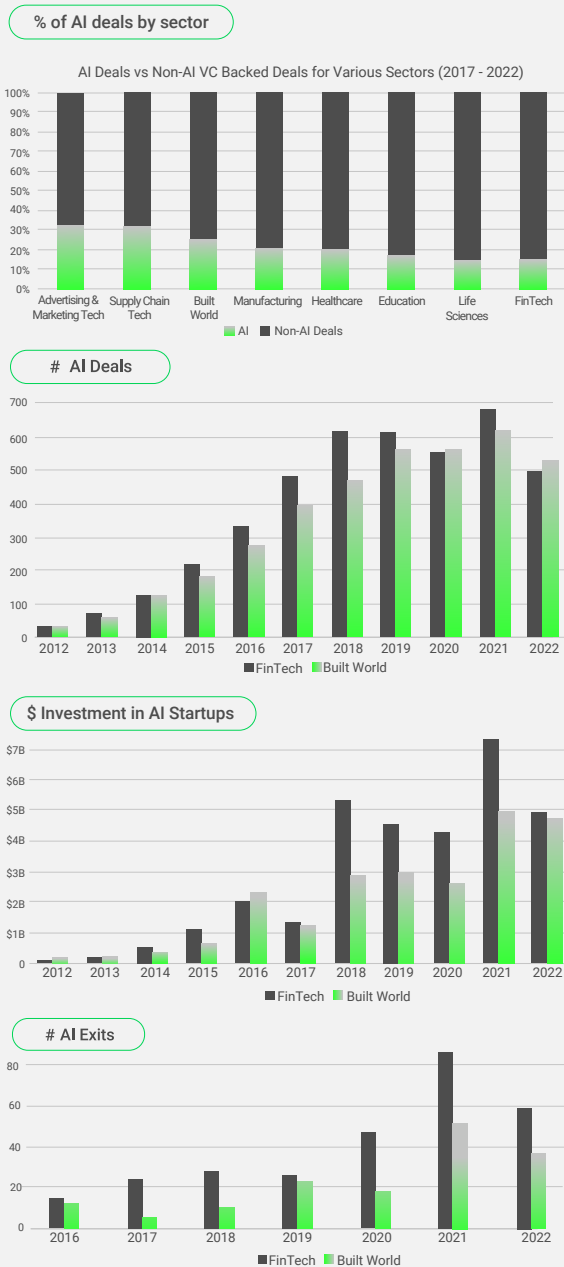
Custom +
high-definition 3D
renders*



Text to Building
Information
Model (BIM)*

Benchmarking Built World AI

Applications of various AI technologies in the Built World ecosystem have been catching up with more mature sectors such as FinTech. Notably, the funding gap between AI deals in the Built World compared to those in the FinTech sector has been closing over recent years. Over the past decade, Built World AI startups received a total of \$24.0B in venture capital funding globally, of which \$18.6B was concentrated in European and North American businesses. In 2021, combined annual investment in the two regions reached \$5B in annual investment for the first time.



In line with the broader macro environment, 2022 saw a dip in deal count and invested capital for AI startups in both the Built World and FinTech.

Figure 6: Comparing AI Venture Activity in the Built World to FinTech, Pitchbook Data, A/O Analysis

Built World AI Investment Overtook FinTech in 2022

AI is core to the Built World technology ecosystem. Over the past five years, 25% of Built World venture deals were in businesses leveraging AI. Comparatively, just 15% of venture-backed FinTech startups across the same time period leveraged any form of artificial intelligence.

While total venture activity in FinTech startups still outpaces that of the Built World, this is not true when it comes to AI. In both 2020 and 2022, AI venture deal count for AI-enabled Built World technologies overtook that of FinTech, reaching a peak of +600 deals in 2021. At the same time, 2022 also saw Built World AI deal volume overtake applications in Advertising + Marketing technology. And, despite a turbulent macro environment, 2022 saw invested equity in AI startups across the Built World and FinTech close to equal for the first time, at just under \$5B globally.

There are a growing number of exits in Built World AI. Recent IPOs for AI-enabled Built World companies are distributed across a variety of themes, including construction products, 3D space capture, energy storage, insurance and real estate transaction solutions. The growing maturity and diversity of the Built World ecosystem suggests further exits in the coming years.

Built World AI IPOs

Matterport2022

Matterport leverages computer vision, machine learning and big data analytics to create robust 3D spatial data from a wide variety of capture devices including LIDAR cameras, 360° cameras, and smartphones.

view2021

View's smart glass uses ambient data from IoT sensors that feeds into their machine learning models for automatically adjusting shading in response to the sun, helping to control heat and glare in commercial buildings while maximising daylight.

blend2021

Blend leverages document processing automation powered by machine learning across the mortgage lifecycle to extract data from documents and trigger workflows based on the document content.

stem2021

Stem's Athena solution uses IoT sensors, big data analytics and decision systems to optimise energy demand, costs and grid resiliency by automatically switching between battery power, on-site generation and grid power.

doma2021

Doma uses document processing automation powered by machine learning and natural language processing across title search, underwriting and closing processes to speed up home closing processes by 15%.

Lemonade2020

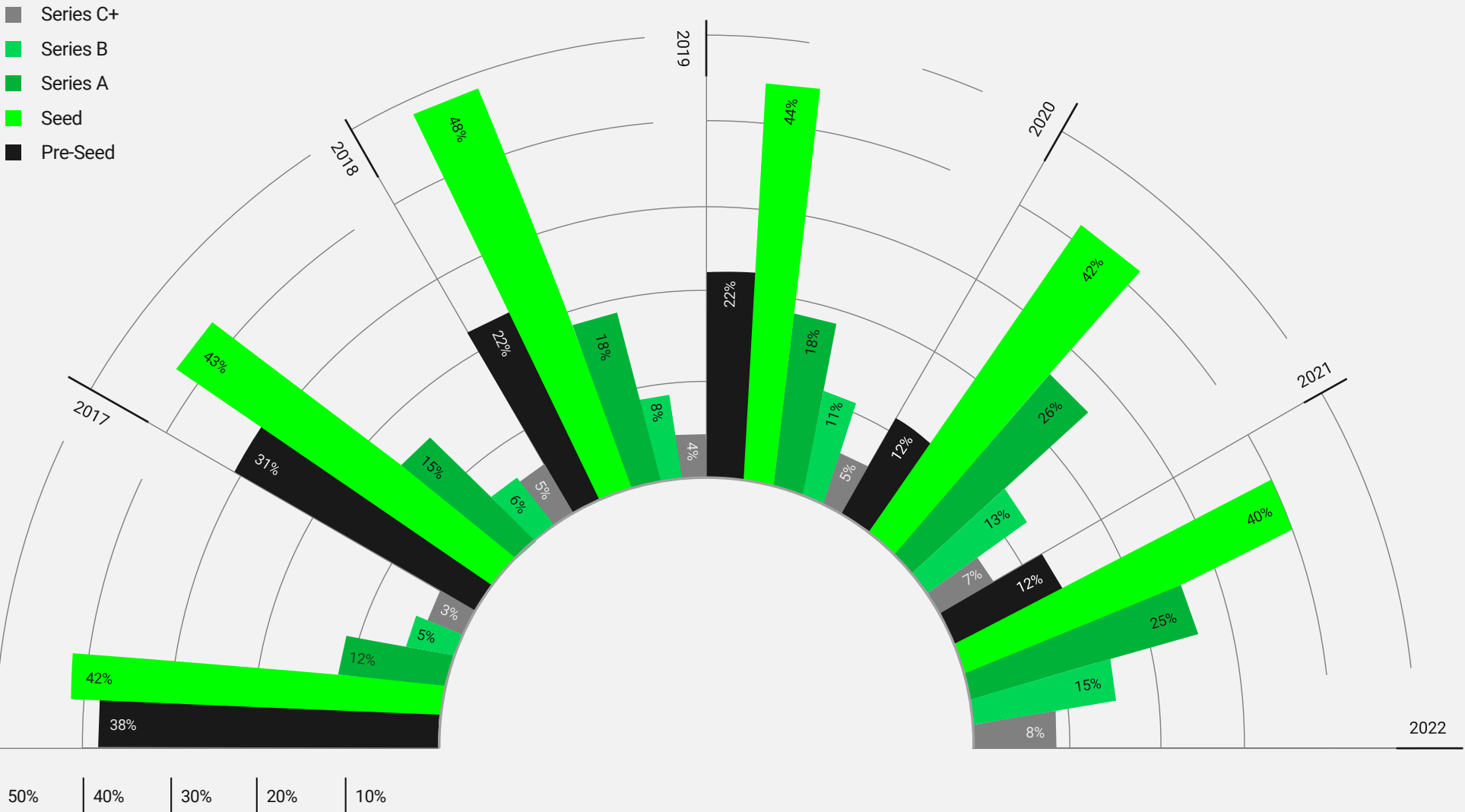
Lemonade uses chatbots and anti-fraud algorithms powered by machine learning, decision systems and big data analytics for customer onboarding and insurance claims processes, with half of claims handled end-to-end without any human involvement.

Built World AI Reaches New Heights

Over the past five years, more than \$18.6B of venture capital has been allocated to European and North American AI startups for the Built World. With \$12.3B raised in the last three years, annual investment more than doubled between 2020-2021 and reached \$4.2B in 2022.

Early Stage Venture Deals Dominate

The past five years has seen the gradual maturation of AI startups in the Built World. Pre-Seed deals, which accounted for ~40% of deal flow in 2017 now account for little over 10% of deals. At the same time, Series A+ deals have grown from around 20% of deal flow to represent 50%. Meanwhile, Seed stage activity has remained broadly consistent, indicating further growth ahead.



+\$18.6B **33%** CAGR

Venture capital allocated to European and North American AI startups for the Built World since 2012

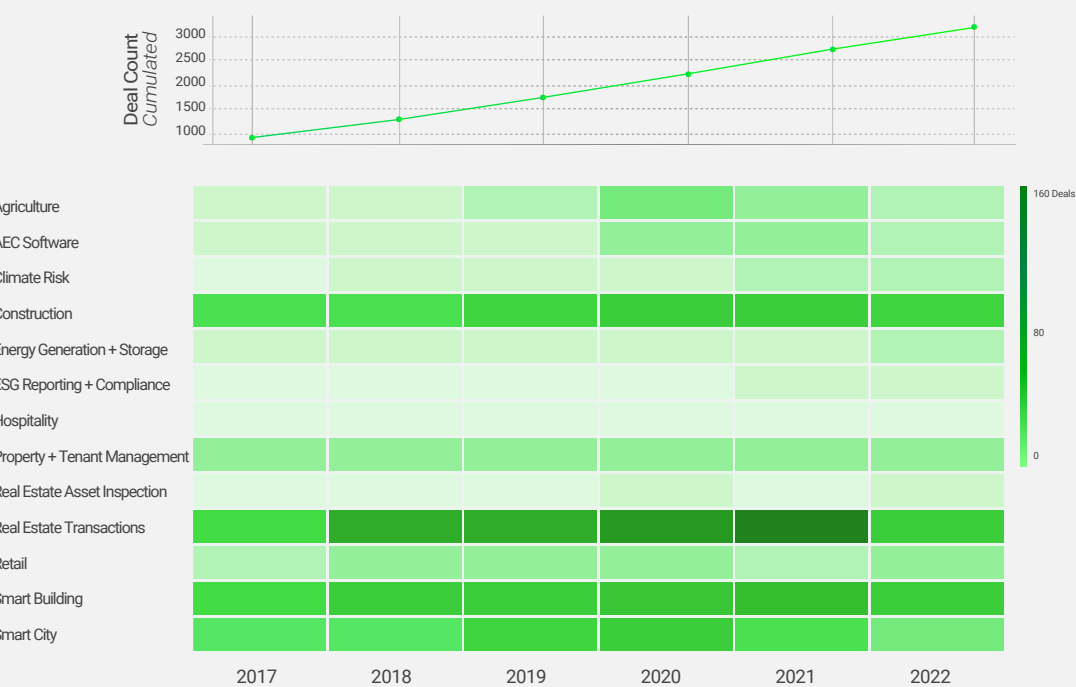
Compounded annual growth rate (CAGR) in investment volumes from 2017-2022

+\$4.0B **+440**

2022 equity investment for Built World AI startups in Europe and North America

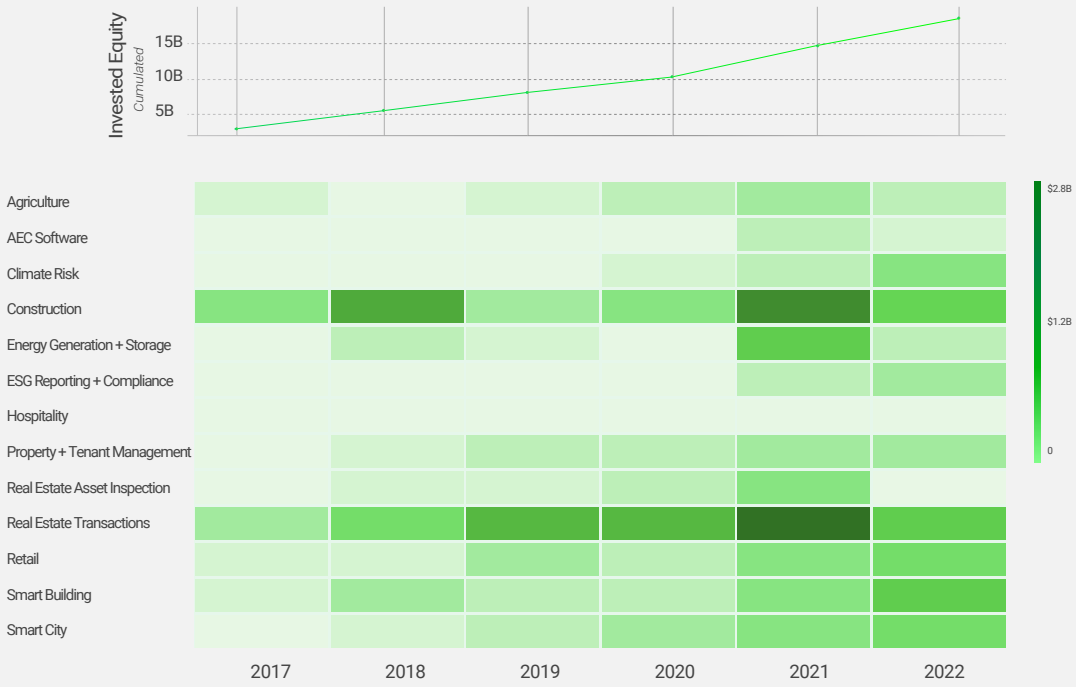
2022 venture deal count for Built World AI startups in Europe and North America

Deal Volume Continues to Rise



Venture deal volume in 2022 was concentrated in real estate transactions, smart building and construction startups.

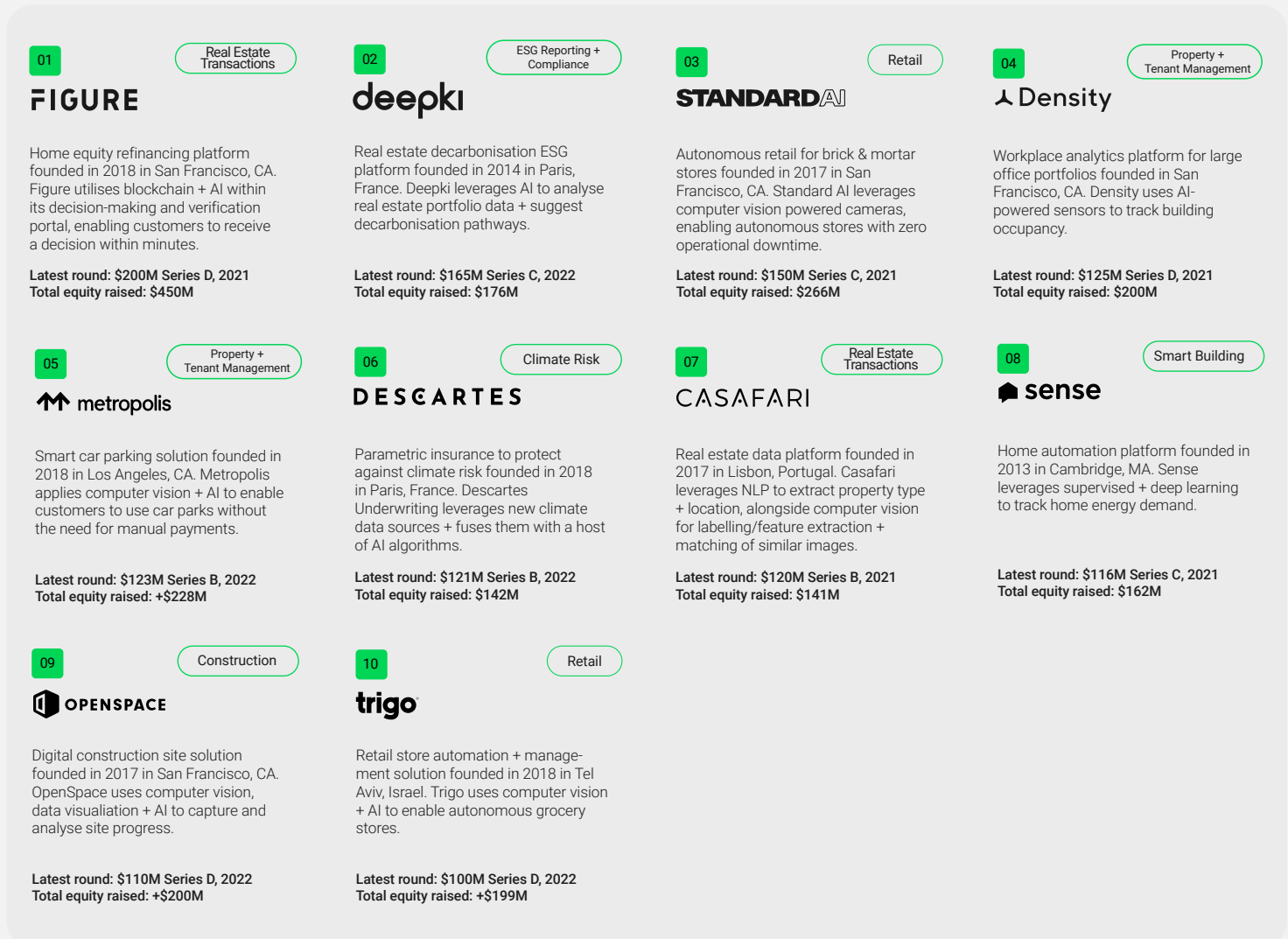
Invested Capital Accelerated in Recent Years



Venture capital dollars in 2022 was concentrated in real estate transactions, smart building, construction and smart city startups.

Investment Trends

Top 10 Venture Deals in Built World AI



The largest Built World AI deals from 2017-2022 took place across 2022 and 2021. These deals were predominantly concentrated in the Built World's most mature segments: real estate transactions, retail, property + tenant management, and construction.

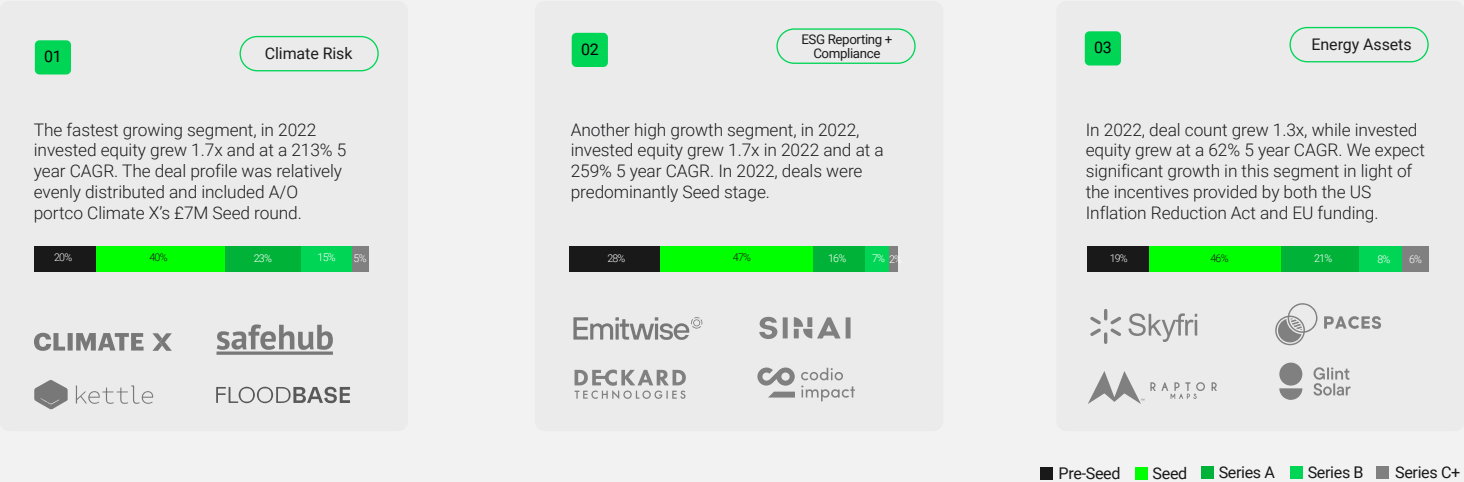
This trend was also reflected in the broader dataset. While the distribution of deal stage across all verticals was relatively even, real estate transaction and climate risk startups saw a greater proportion of Series B+ deals.

At the same time, both property + tenant management and retail segments saw a strong concentration of Series B deals. Interestingly, 2022 also saw two large climate technology deals: Deepki raised a \$165M Series C for their real estate ESG decarbonisation platform, while Descartes Underwriting raised a \$121M Series B to scale up their parametric insurance offering.

Also notable was the close to even split between North American and European companies across the top 10 deals.

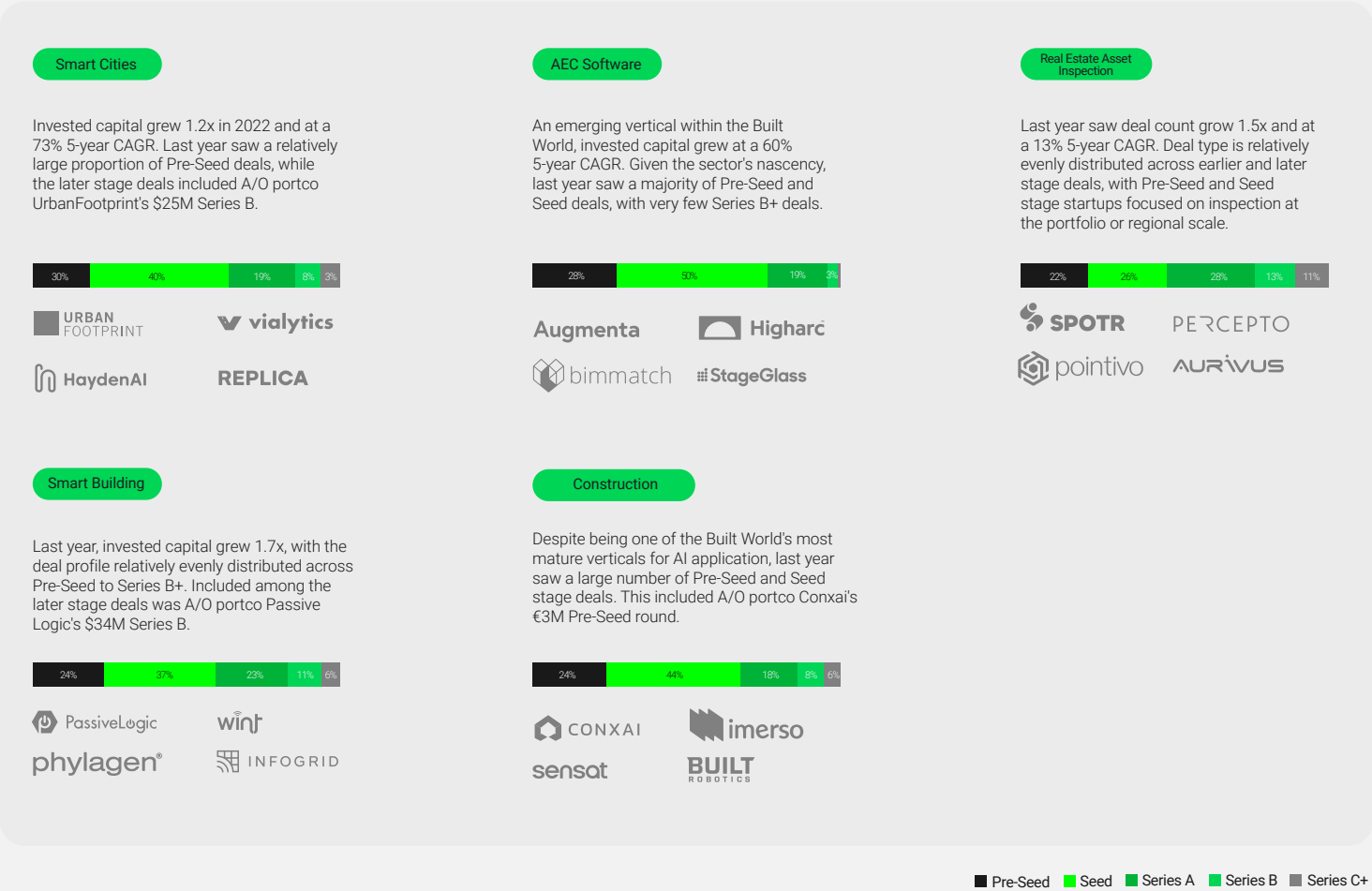
Fast Movers in Built World AI

Over the past five years, Climate Risk, ESG Reporting + Compliance and Energy Assets have emerged as the top three fastest growing verticals for AI application in the Built World.



Other Growth Verticals

Last year also saw a high proportion of Pre-Seed deals in AEC Software and Smart Cities. Other segments are starting to mature, with a growing number of Series B+ deals in both Smart Building and Real Estate Asset Inspection.



United States vs Europe

London is the top city for Built World AI deal count globally, and the top European city for invested capital. Overall, US cities continue to take the lead on invested capital.

Deal Distribution By Vertical

- Agriculture
- AEC Software
- Climate Risk
- Construction
- ESG Reporting + Compliance
- Energy Generation + Storage
- Hospitality
- Other
- Property + Tenant Management
- Real Estate Asset Inspection
- Real Estate Transactions
- Retail
- Smart Building
- Smart City

Top 10 Cities by \$ Invested Capital

2017 - 2022

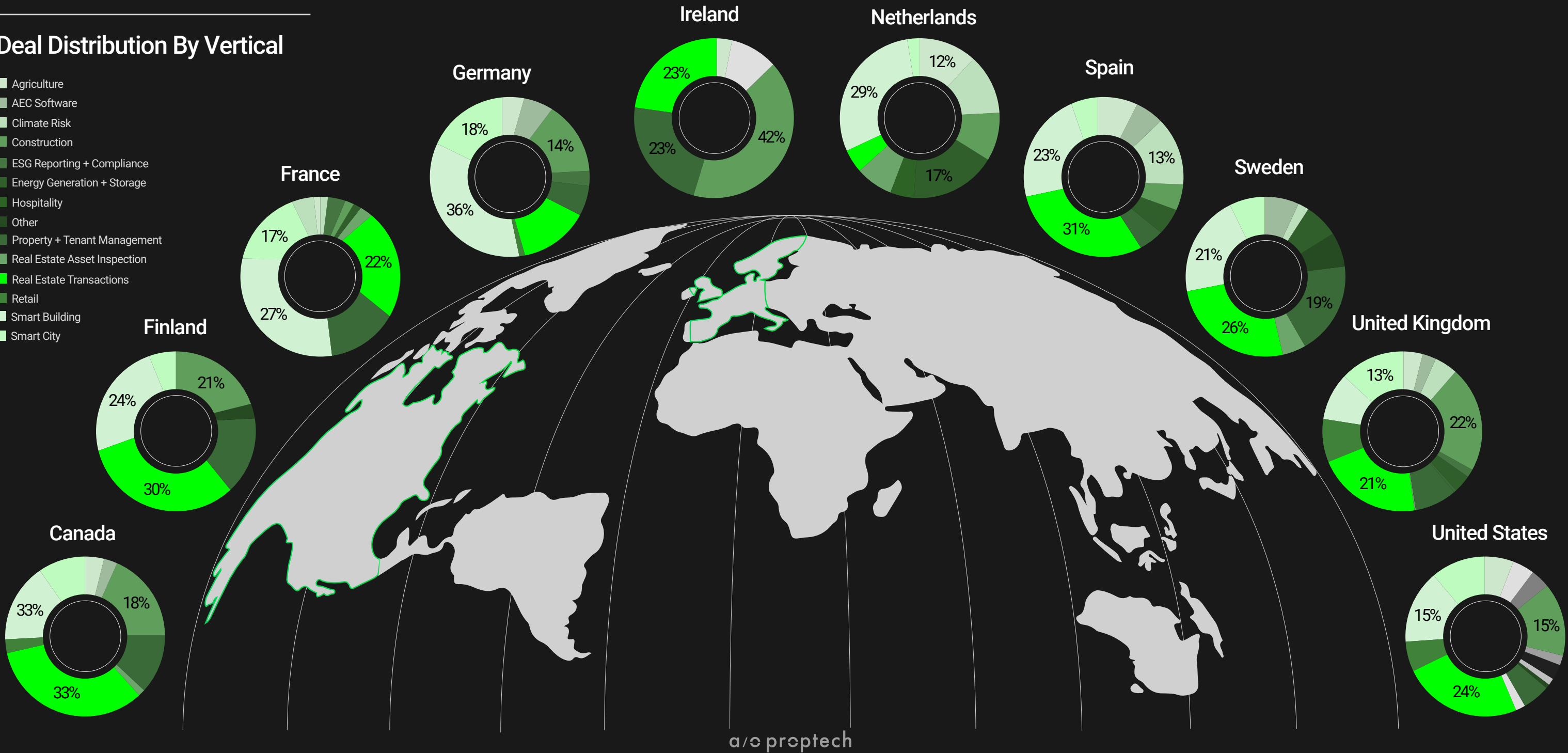
- | | | | |
|----|-------------------|----|------------------|
| 01 | San Francisco, CA | 06 | Tel Aviv, Israel |
| 02 | New York, NY | 07 | Reno, NV |
| 03 | Milpitas, CA | 08 | Hayward, CA |
| 04 | London, UK | 09 | Cambridge, MA |
| 05 | Paris, France | 10 | Montreal, Canada |

Top 10 Cities by #Deals

2017 - 2022

- | | | | |
|----|-------------------|----|-----------------|
| 01 | London, UK | 06 | Toronto, Canada |
| 02 | San Francisco, CA | 07 | Seattle, WA |
| 03 | New York, NY | 08 | Berlin, Germany |
| 04 | Paris, France | 09 | Dublin, Ireland |
| 05 | Tel Aviv, Israel | 10 | Chicago, IL |

North America Europe



Methodology



The solutions outlined on this report focus on 2012 to 2022 (inclusive) early stage deal data gathered from Pitchbook. We have identified +1300 companies globally and +1050 with headquarters in North America and Europe. Of these companies we have analysed those that raised disclosed investment rounds from 2012 to 2022, and importantly which identify as using AI as part of their technology stack.

Notably, this report has been produced using A/O's vertical classification which leverages pre-trained models, while the technology verticals were analysed using NLP from the company descriptions from Pitchbook and LinkedIn.

For the capital allocation analysis, we have chosen to focus on early stage equity deals, including: all venture capital deals, angel investments and crowdfunding rounds.

We have excluded: debt financing, private equity, secondary transactions, public offerings and SPACs.

Where an investment's deal size has not been disclosed on Pitchbook, we have used Crunchbase data. Where the deal size is not disclosed on either Pitchbook or Crunchbase, we have chosen not to include the deal in our deal count analysis.

Given the rapidly evolving startup landscape, our segmentation of the market relates only to how we at A/O perceive the current state of the built world market.

Acknowledgements

At A/O we pride ourselves on our data-driven approach to venture capital investing. This report is the result of interdisciplinary collaboration across investment, data science and design. If you are a founder or real estate leader tackling building decarbonisation or interested to learn more, reach out to one of our team below. This report forms part of an ongoing A/O series covering emerging built world technologies.



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Catriona focuses on research-driven sector analysis, including the identification of core trends, assessment of market dynamics and evaluation of investment targets.

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Jayasmita focuses on extracting and analysing company data to automate key tasks as well as conducting technical due diligence to support investment activities while using the latest advancements in data science and software engineering.

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Creative Director

Mounia is an experienced designer and marketer. She drives branding, content creation, marketing, and social media at A/O PropTech, to enhance the firm's presence and business development objectives.

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Gregory Dewerpe

Founder - Chief Investment Officer

Gregory is one of Europe's leading proptech venture capitalists and a long standing, prominent voice promoting the acceleration of positive transformation in the built world. He founded A/O on the back of a deep understanding of the industry's shortcomings.

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