

*Design for
what's next*

ARUP
80 YEARS

AI Enabled Optimisation for Cost and Sustainability Decision Making

Arup

Michael Chin

Our firm

We guide, plan and design the
future of the built environment

We are a global consultancy with extensive
technical and advisory expertise.

Arup worldwide

1946

Founded by Sir Ove Arup

17,000+

People

£2.2bn

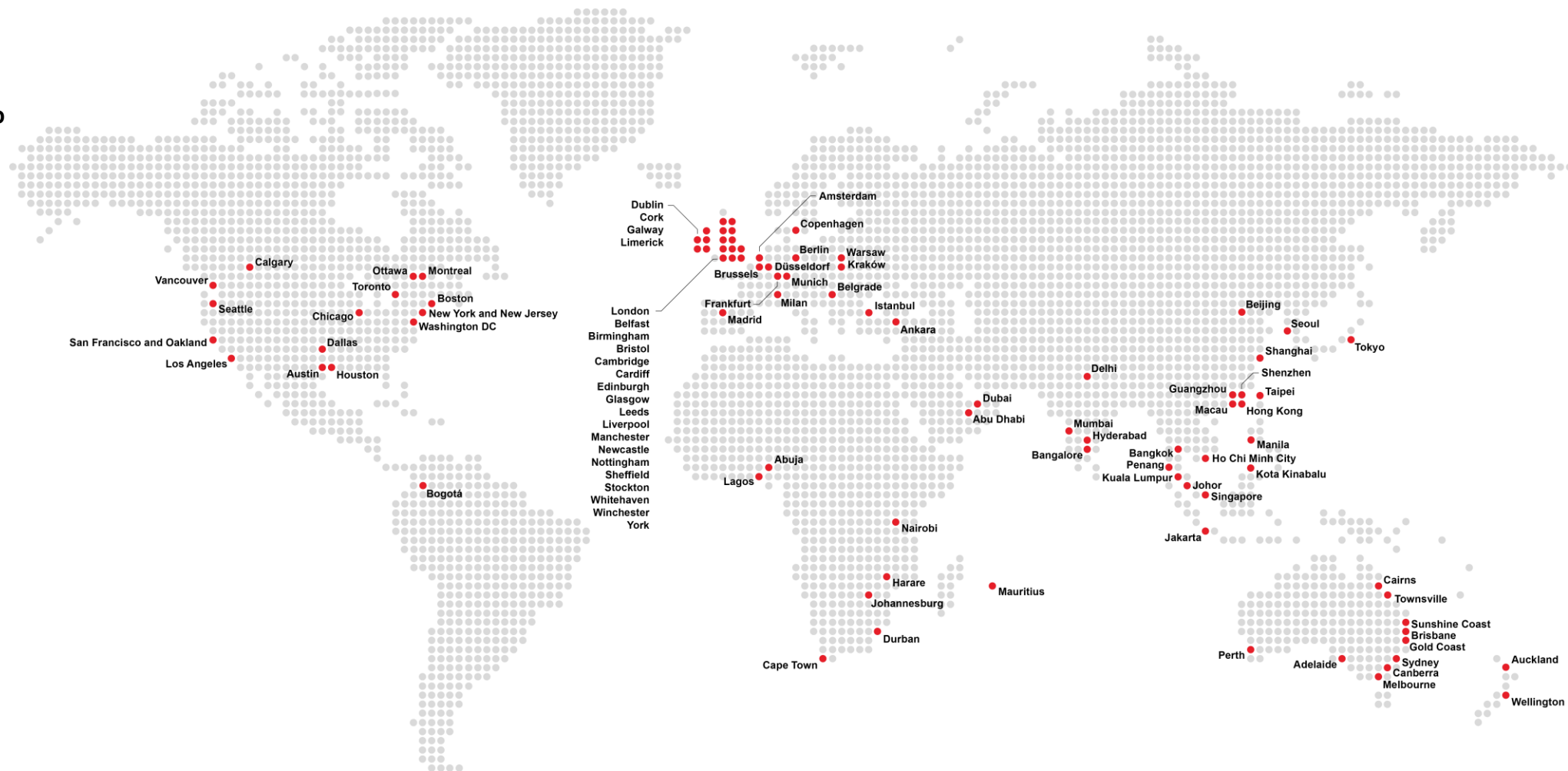
Turnover (2024/25)

100+

Offices

35+

Countries



Arup in APAC

- 30 offices across APAC
- Launched our APAC first office in Sydney, Australia in the 1960s to design engineering solutions for the iconic Sydney Opera House



Our former chairman, Jack Zunz, explaining our design of Sydney Opera House to Bob Heffron of Australia's New South Wales government (01 June 1963)

We are deeply committed

1963

First office opened

6,400+

People

30

Offices

150+

Disciplines



Arup in Southeast Asia

Arup has been in Southeast Asia for over 60 years and has longstanding offices in Jakarta, Kuala Lumpur, Manila and Singapore.

60+ years of city shaping history

1,300+ employees

10 offices



Arup in Singapore

Arup have been shaping our young, dynamic nation since 1968. Our global and local expertise in tackling urban challenges unique to Singapore has made us the designers, engineers, planners and strategic advisors of choice for many local and international clients.



Our markets and services

We offer an extensive range of services, relevant to global markets.

Markets

Energy

Water

Resources

Transport

Property

Healthcare

Science

Industry

Technology

Cities

Education

Sports and Leisure

Services

Architecture

Planning

Design

Advisory

Engineering and
Technical Services

Climate and
Sustainability

Digital

The future we choose

Arup Strategy

2025 - 2030

Our priorities

Bring Total Design to every client

Be more immersed in our markets

Create an agile, borderless organisation

Invest in an industry-leading
member experience

Our purpose

We shape a
better world

Our impact

Enhancing our core strength businesses
Property and Transport

Investing in accelerator businesses
*Energy, Water and Science,
Industry and Technology*

Amplifying our global impact
Americas, Europe and Southeast Asia

Investing in future markets
India, China and Africa

Total design

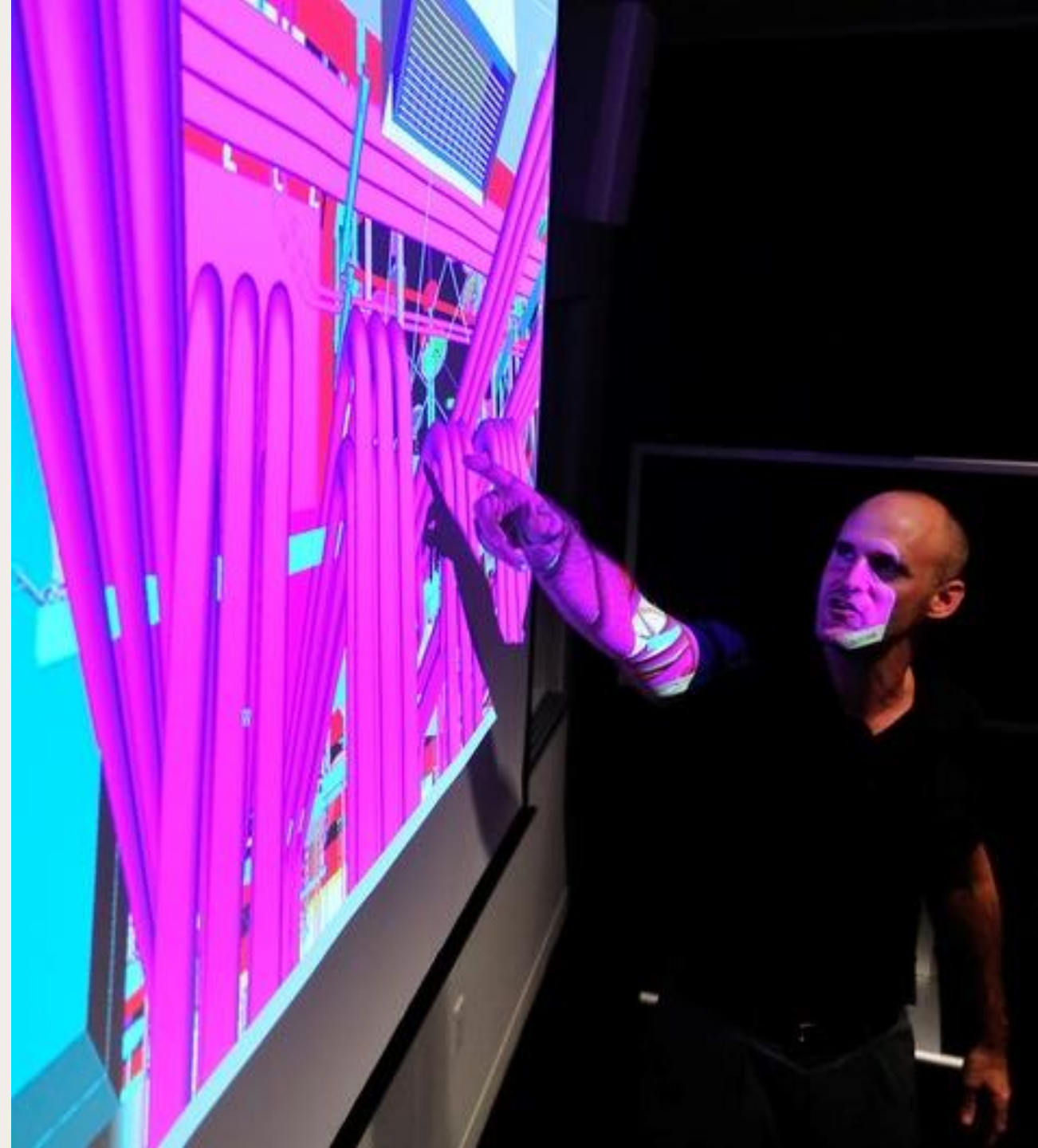
Total Design is our distinctive way of working

It delivers meaningful value for clients, society and the environment while ensuring meaningful experiences for our members.

Digital

Digital innovation backed by deep domain knowledge

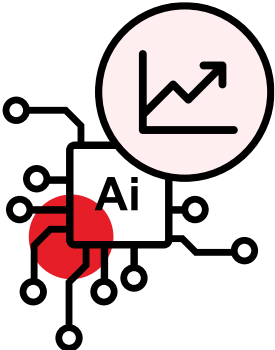
Arup helps clients and projects take full advantage of the exciting new opportunities that arise from digital, data and AI.



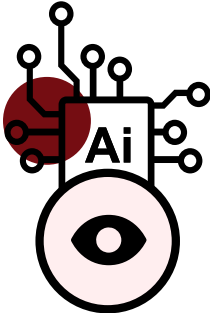
AI in Singapore

Our projects

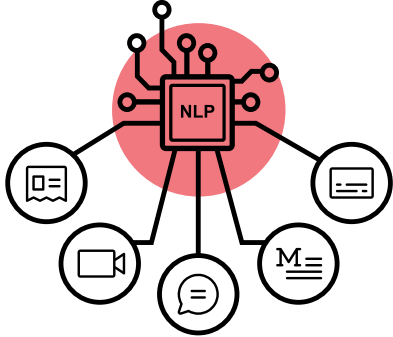
Including developing and deploying real world solutions using the **range of AI systems** of greatest use in the AEC sector



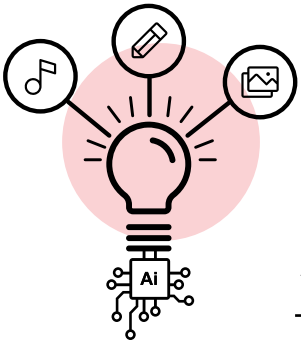
Predictive AI



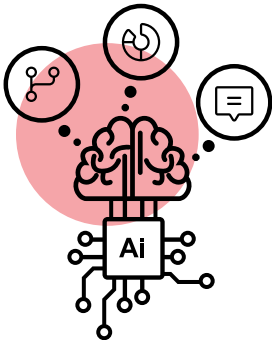
Vision AI



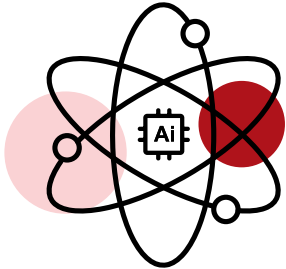
Language-Based AI



Generative AI



Agentic AI



Science-Based AI

Global

The future we choose

Arup Strategy
2025-30

- Let's talk about the future
- Our purpose is our strength
- Our four strategic priorities
- The impact we will have
- The path to success
- The role we all can play

Artificial Intelligence (AI) Policy

At Arup we see AI, as defined by the OECD, as a pivotal technology that will augment our collective and creative intelligence, judgement, and expertise. We aim to design and use AI to drive quality and growth for our clients and our projects in a way that enhances our delivery of total design and supports our pursuit of excellence. The AI systems we "take, shape, or make" will accelerate our mission to shape a better world, guided by key principles aligned with our strategy and values.

Aims
Safety: AI systems operate as we intend them to, with sufficient reliability, robustness and security.
Compliance: AI systems comply with relevant regulations and laws.
Transparency: transparent AI systems foster our clients' trust and our members' confidence in using AI.
Accountability: humans bear responsibility for AI systems and outputs.
Fairness: AI systems and outputs do not discriminate unfairly against members, clients, or the public.
Sustainability: environmental and social impacts are carefully assessed in our use and design of AI.

We will
Deploy approved AI systems that align with our purpose, internal policies, client requirements, and applicable laws and regulations. The use of AI will be supported by proportionate risk assessment, assurance mechanisms, and ethical, secure data handling in line with established data governance protocols.
Equip our people with the guidance, training, and oversight required to understand and responsibly apply AI. We will foster a culture of curiosity and critical thinking and take steps to embed diversity of thought and expertise in the design and use of AI.
Arup will actively manage AI systems throughout their lifecycle to ensure they remain fit for purpose, safe, and effective. We will maintain regulatory oversight, research, learning and engage partners to enable best practice as technology, regulation, and societal expectations evolve.

Governance
This policy is set by Arup Group Limited Board and implemented across all Arup operations through policy, procedures, management systems and learning. It is reviewed and approved annually, or more frequently if appropriate.
The Chief Digital and Information Officer acts for Arup in ensuring that plans are developed, implemented, and monitored to enable us to reach the aims set out in this policy while fulfilling applicable legal, regulatory, and other requirements.
"It is not the wish to expand, but the quest for quality which has brought us to this position, for we have realised that only intimate integration of the various parts or the various disciplines will produce the desired result." - Key Speech, 1970

James Price
CEO, Arup Group Limited
April 2024



Key initiatives

Strengthen FY25/26

| Transformation Partnership – AI, Data and Technology | | | Digital Technology | | |
|---|---|---|--|--|--|
| Data Step Change | AI for Everyone | Digitalised Design | Product Engine | Project Digital Index | ISO 27001 |
| Harnessing data to drive innovation and efficiency <i>Transforming the data ecosystem to boost project quality, reduce costs, increase revenue and accelerate innovation</i> | AI for innovation aims to drive innovation in business operations and project delivery <i>Building AI competencies for everyone alongside development of advanced AI enterprise scale capabilities</i> | Digitalising design and engineering workflows providing a competitive edge and managing engineering processes <i>Standard approaches, leveraging technology, and ensuring business driven prioritisation</i> | Professionalising product development and validating market opportunities <i>Aligning product development with industry standards, governance, and market data</i> | Rethinking digital maturity in the context of data and AI <i>Measuring toolset usage, expertise mobilisation, and continuous learning</i> | Achieving certification to strengthen market position and mitigate security threats <i>Certification is essential for work winning and maintaining competitive edge</i> |
| DT Cont'd | | Transformation Partnership - Enterprise Systems | | | |
| Digital Innovation Framework | Apex | Fusion (People System) | Finance Management Systems | Knowledge Management System | |
| Professional discovery, triaging, development, and commercialisation of market-driven innovative digital products and partnerships. <i>Aligning product development with industry standards, governance, and market data</i> | Implementing a new project delivery solution to support project teams <i>Focus on reducing wasted time, improving user experience, and integrating fragmented systems</i> | Delivering a single global cloud-based people technology platform <i>Modernising and simplifying people services, increasing self-service options, and providing a single source of people data</i> | Rationalising the finance ecosystem and mitigating risk <i>Standardising processes, rolling out JD Edwards, and addressing compliance and regulatory requirements</i> | Becoming a world-class knowledge organisation <i>Comprehensive consultation to identify critical needs and targeted interventions</i> | |

Arup Strategy

AI Policy

Global Vision & Roadmap

AI for Everyone

FY26/27

AI Platform Scaling

Focus

- Stand up Enterprise AI Platform
- Build AI model capabilities (surrogates, sensitivity analysis etc.)
- Expand Agentic AI pilots into structured workflows (design engineering)
- Broad adoption of Phoenix across Skills Networks

Outcomes

- Self-serve AI capabilities becoming available for projects (design and advisory)
- First multi-project re-use of AI models

FY27/28

Business Integration

Focus

- Embed AI capabilities into core workflows (design, maintenance, assessment, planning)
- Integrate AI models into client advisory offerings (probabilistic analysis, scenario modelling etc.)
- Mature agentic AI assistants
- Cross-disciplinary ethical AI leadership

Outcomes

- Thousands of members use Advanced AI in projects and advisory
- AI directly differentiates Arup client projects and opportunity wins
- New advisory products powered by AI
- Cultural adoption of AI as standard practice

FY25/26

Foundation Building

Focus

- Deploy M365 Copilot for everyone
- Ramp up adoption of Phoenix platform
- Evidence Advanced AI capabilities and value
- Establish ethical AI principles

Outcomes

- Efficiency gains across firm
- Credibility through Advanced AI use-cases
- Shared AI governance and guardrail principles

FY28/29

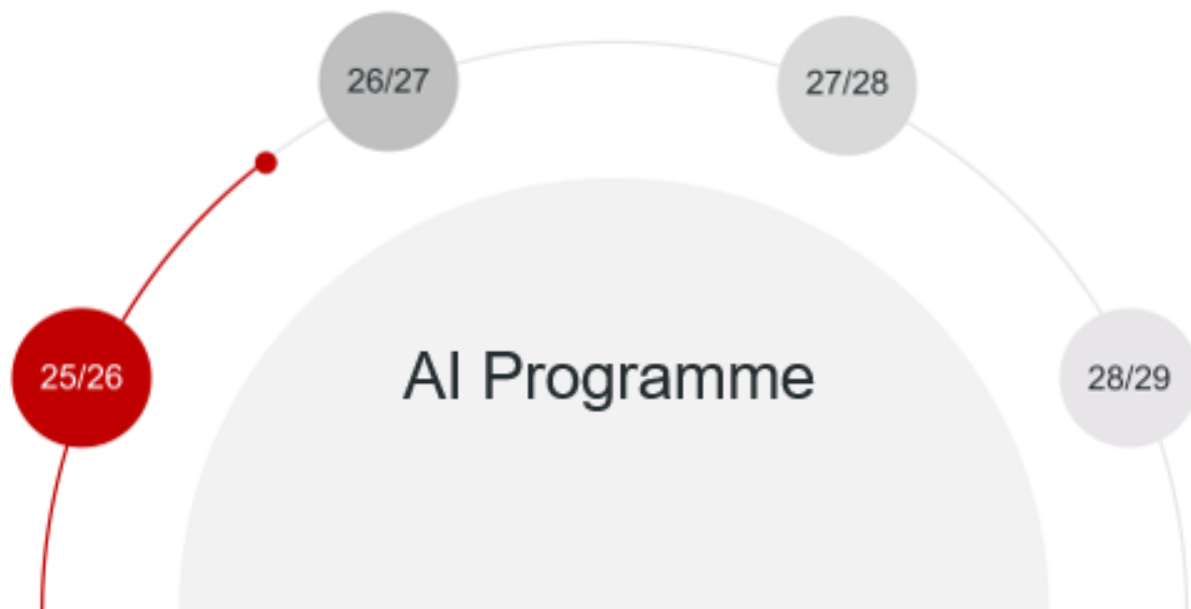
Industry Leadership

Focus

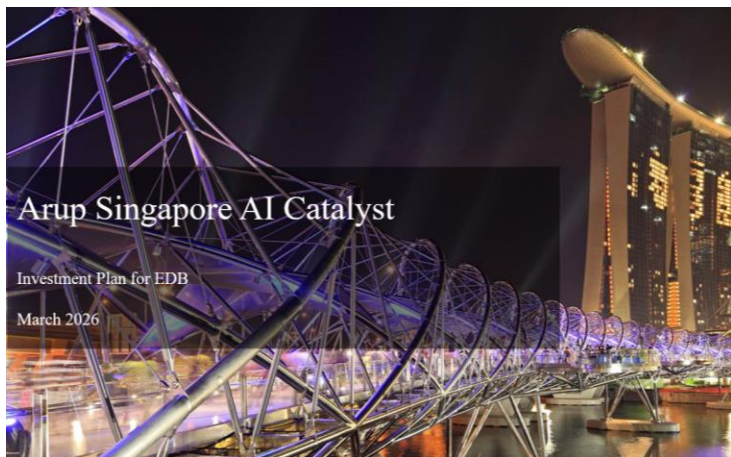
- Fully integrated AI as a Platform across strategic and accelerator businesses
- Establish partnership ecosystem (suppliers, academia, startups)

Outcomes

- Recognised as an AI leader in AEC
- Revenue diversification through AI
- Resilient AI operating model supporting majority of the firm



Singapore Activity



**EDB Supported
Proposal Arup
Singapore “AI
Catalyst”**


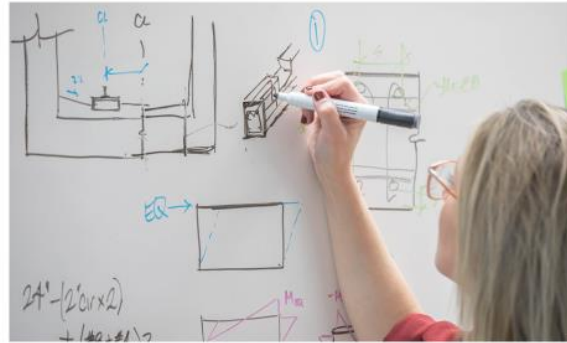








**AI & Databricks
Training**



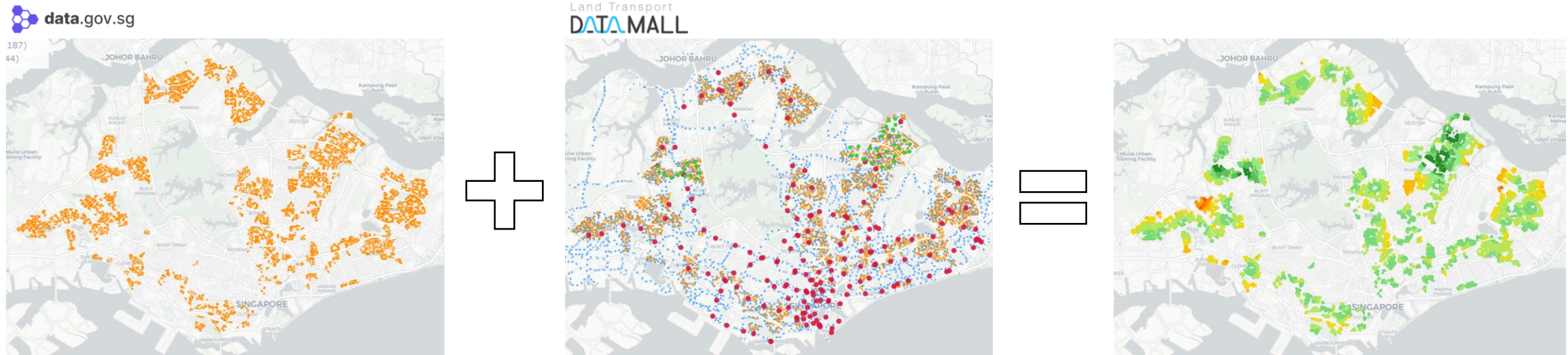
**Client AI
promotion and
projects**

Singapore AI Catalyst Investment Proposal

| | | | |
|---|--|--|---|
|  | <p>Recruitment</p> |  | <p>Agentic Transformation</p> |
|  | <p>Skills Development</p> |  |  |
|  |  |  | <p>Market Engagement</p> |

HDB Connectivity Mapping

A Databricks Demo



HDB Existing Building Data from
SG Open Data Portal

Bus Stop and Train Station from
LTA Data Mall

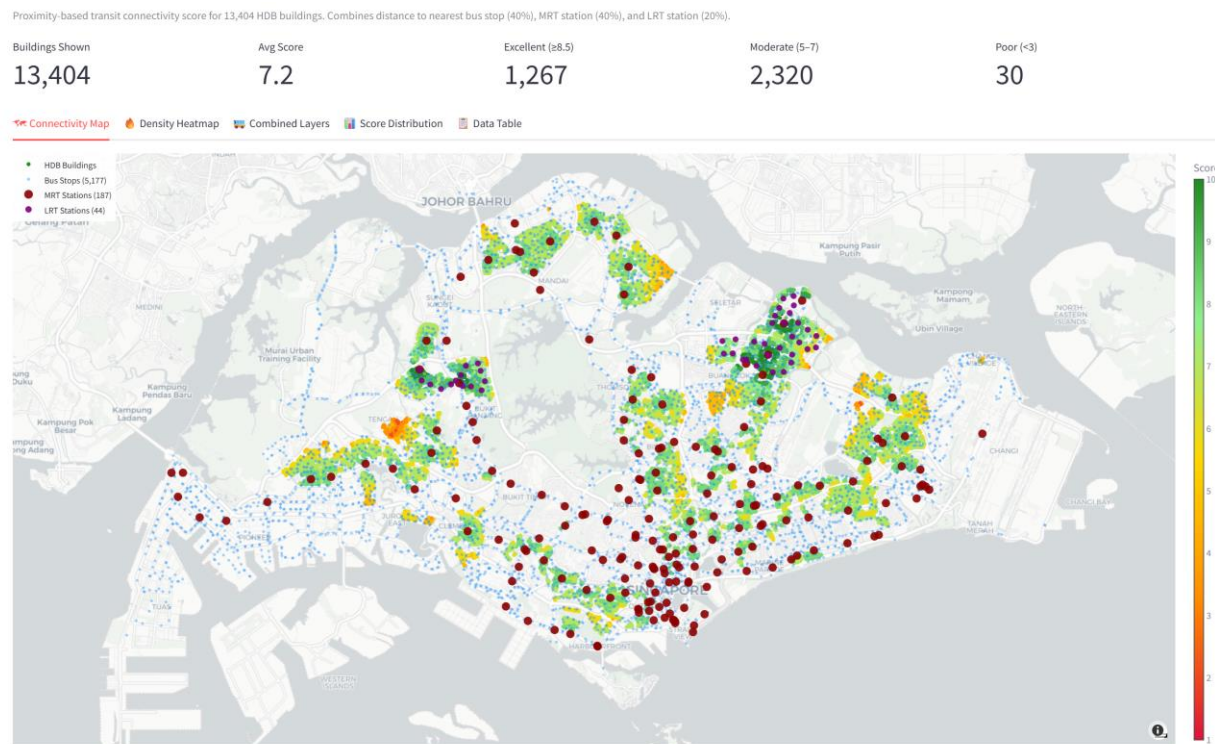
Connectivity assessment and scoring for
all the HDB Buildings across Singapore

- Leveraged Databricks and the AI agent Genie to rapidly develop a Python-based notebook for data cleaning, connectivity assessment, and visualization.
- The entire workflow was completed within one hour during the workshop.

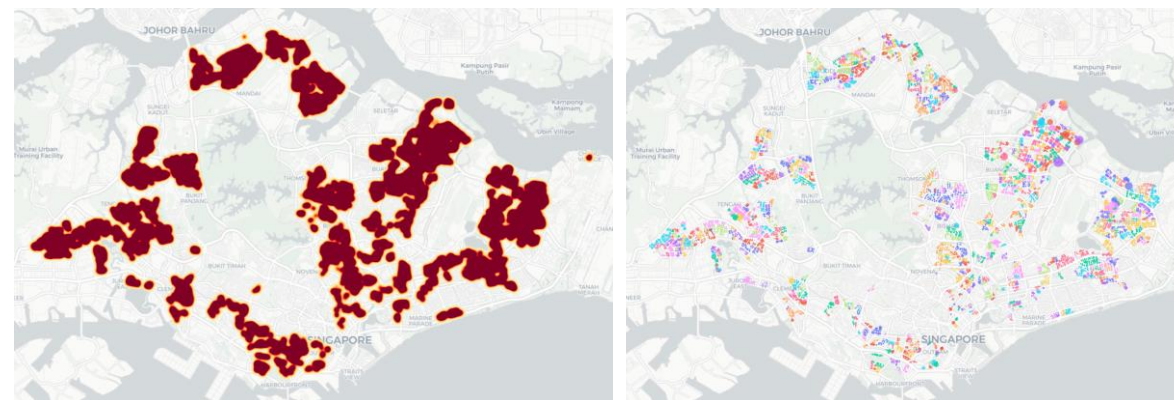
HDB Explorer

A Databricks Demo

- An interactive web application was directly built from the notebook [HDB Buildings Explorer](#) (Databricks accesses required)
- Additional data and functionalities can be incorporated, and it is possible to integrate other public datasets.
- Further enhancements can also be achieved by incorporating domain knowledge into the application.



HDB Explorer Map



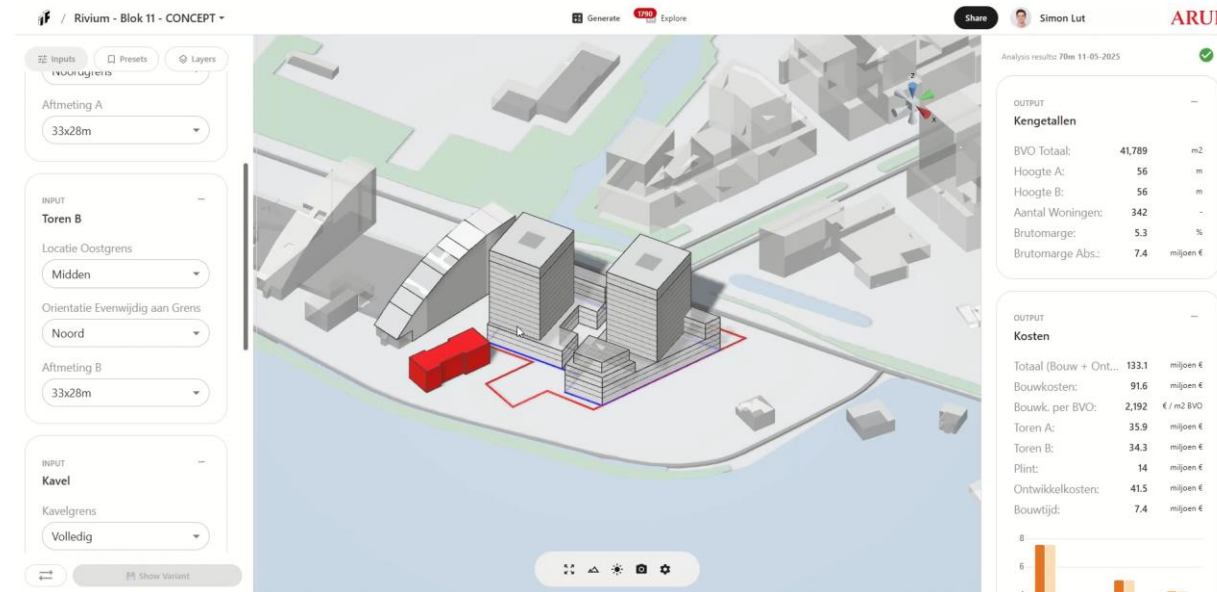
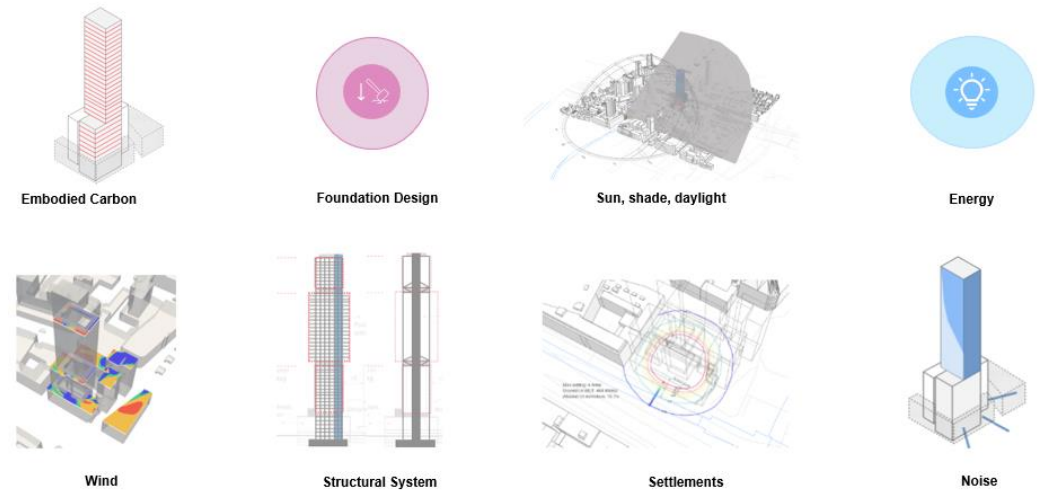
HDB Density Heatmap

Existing HDB by Street

Generative algorithms and AI to optimise and speed up early-stage building design

Arup InForm

- Designing buildings is more complex than ever. Early-stage design must integrate and deal with competing pressures like urban densification and environmental demands.
- Arup InForm brings clarity to this complexity. Our designers define project constraints and goals using computational solvers and parametric scripts.
- Generative algorithms then generate thousands of design options in minutes. We analyse and compare these using multi-objective optimisation techniques. InForm is AI-enabled: ML surrogates predict option performance to reduce heavy simulations, and ML-guided search focuses exploration on the most promising candidates.
- We used inForm to help cut embodied carbon by over 50% in the design of the Elements Building and to help sequester 1,800 tonnes of CO₂ in the design of HAUT.



Over 50%

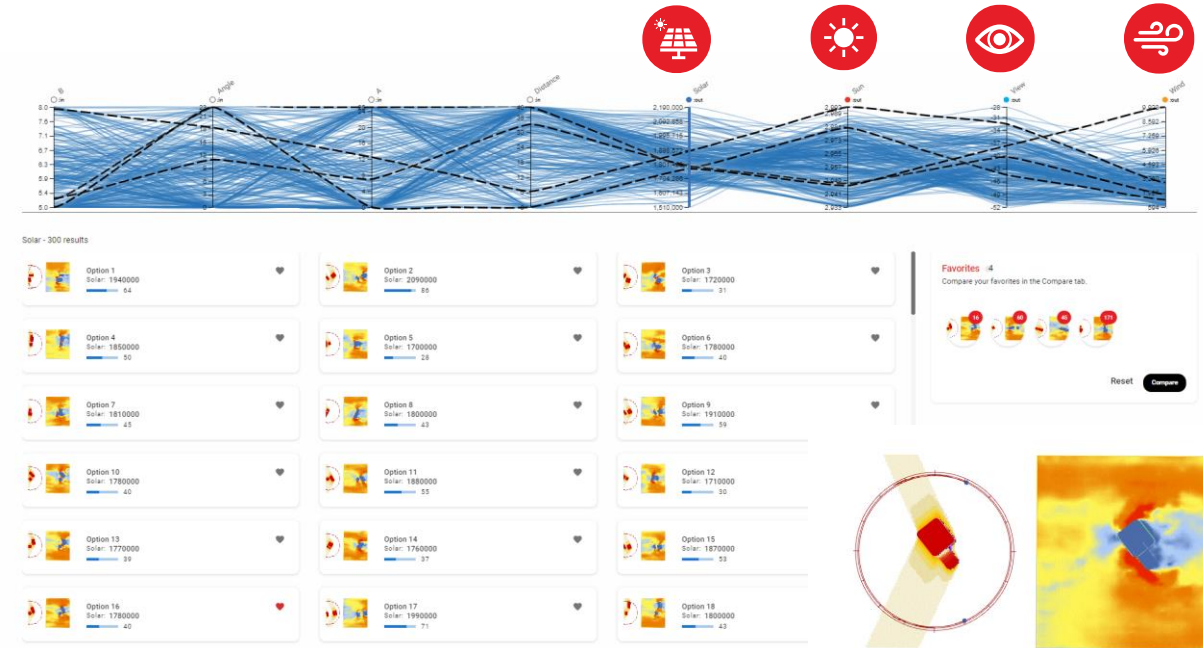
Less carbon embodied and operational carbon in Elements design.

1,800 tonnes

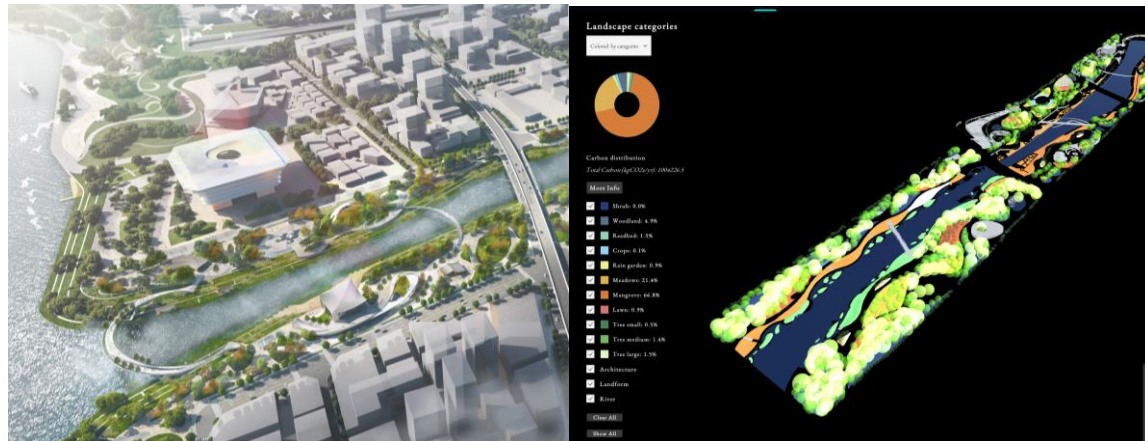
CO₂ stored in the structure, when sequestration is included.

Total Digital Design leading to more sustainable design

- A data driven design approach for building projects that takes consideration all the metrics which can efficiently generate, analyse, and explore the solution space.
- For example, GF, sunlight, safety, constructability, daylight, solar potential, noise, wind &c
- Facilitates **informed decision-making** and **managing risk** start from early stage. This allows us evaluate **thousands of options** and chose the best ones with balance in cost, comfort, and sustainability.



AI for simulations predictions



900 tonnes

Annual Carbon Sequestrations

60%

Carbon reduction in building design.

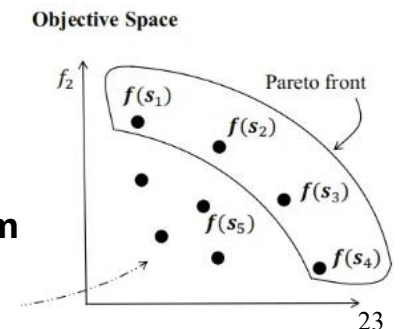
Design Space Optimization

102,336 Iterations



300 Good options

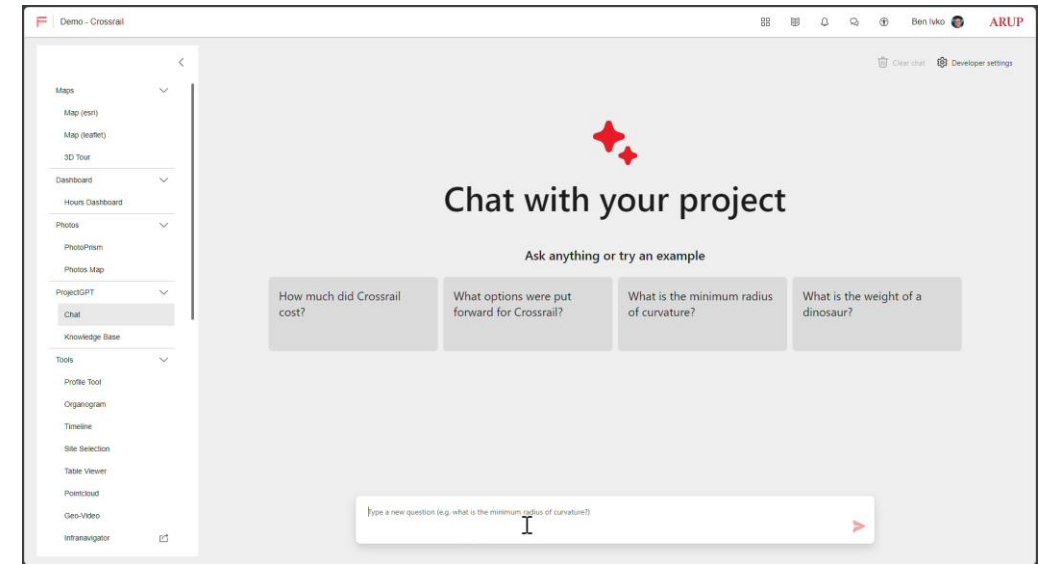
Using Design Space Optimization algorithm to reduce from 102,336 to 300 iterations, while keeping the same design space



LLM-based Fuse.AI reducing time and errors on complex projects

M5, Copenhagen

- Major projects like M5 generate massive amounts of data and people struggle to find the information.
- Fuse.AI's AI-driven natural language processing enabled the M5 Metro design team to instantly retrieve and summarise relevant information from thousands of documents, dramatically reducing time spent searching and minimising costly errors.
- Designers and project leaders could ask complex, project-specific questions in plain English via a chatbot interface.
- Unlike traditional keyword searches, the AI understands context and intent, delivering precise answers and direct links to source material.
- The AI was iteratively improved through prompt engineering and user feedback.
- Use of large language models to deliver instant, context-aware answers is groundbreaking, setting a new standard for digital innovation in infrastructure design and assurance.



Empowering data-driven building energy management and optimisation through AI and BIM



Neuron Smart Building Platform

Challenge

Buildings consume 90% of total electricity consumption in Hong Kong through heating, ventilation and air-conditioning (HVAC) systems. Accurate energy usage forecasts and optimised control of buildings' HVAC systems are critical for energy saving.

Solution

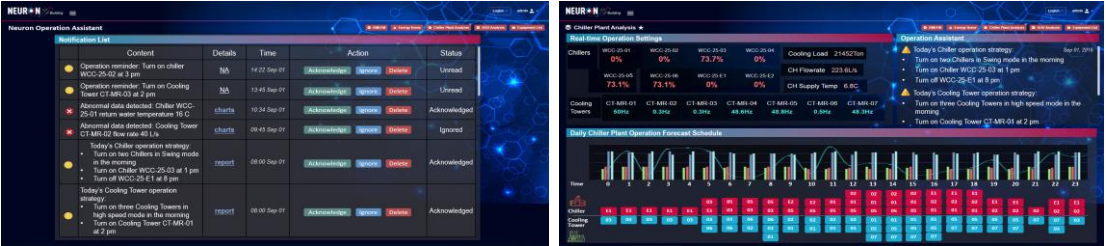
An intuitive and fully customisable visualisation tool that enhances buildings' energy savings and efficiency, optimises operational workflows. Through the use of AI and big data technology, Neuron can analyse the real-time building data generated from various building systems and provide us the insights of the building performance.

Outcome

By learning the historical data with machine learning, it helps us to predict the building performance with optimised setting so that the building management system can adjust automatically better performance and savings.



Up to **30%** Saving of energy consumption in a typical existing commercial building.



Using AI to predict the remaining service life of concrete

ConQUEST

- Global cement production is responsible for about 8% of the world's total CO2 emissions.
- Reinforced concrete structures degrade over time due to carbonation and chloride ingress, leading to reinforcement corrosion and reduced service life.
- Current methods of service life assessment are guided by standards and include deterministic approaches which extrapolate from measured data.
- ConQUEST is an advanced AI-powered tool which predicts the material and environment properties of concrete infrastructure using on-site measurement data and industry-standard estimates.

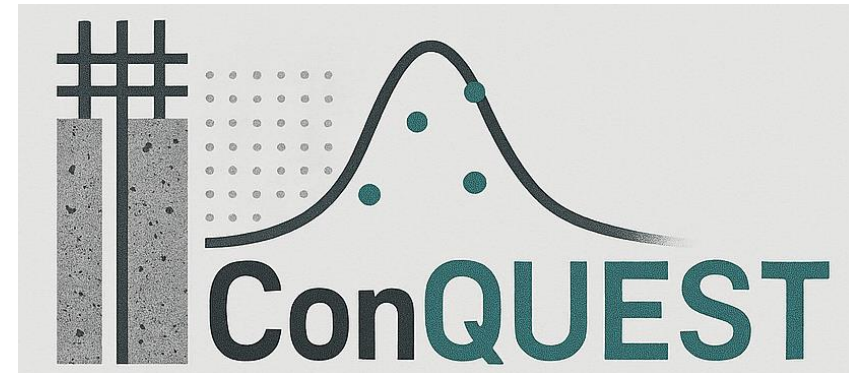
- ✓ **Dynamic and accurate service life predictions**
- ✓ **Informed and efficient maintenance strategies**
- ✓ **Quantified uncertainties**
- ✓ **Benchmarked asset performance**

> 60 years

Residual life extension, Haug Bridge, Norway.

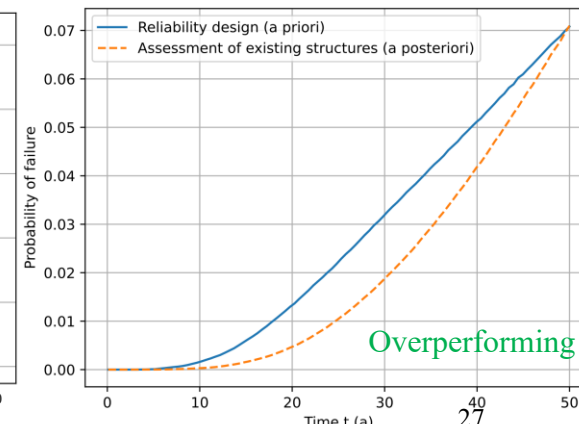
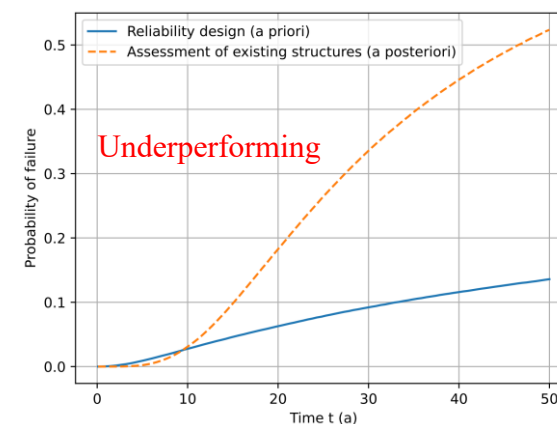
10%

Reduction in risk due to depassivation (at 100 years), Haug Bridge, Norway.



Asset performance:

- **Underperforming** -> early intervention -> safety
- **Overperforming** -> defer maintenance -> sustainability



Refurbishing and repurposing existing buildings in a way we were never able to do before



Portland House, London

Reusing rather than demolishing and rebuilding. Used advanced ML to learn the structural performance of the building after 60 years of ageing.

52%

Reduction in embodied carbon



Procuratie Vecchie, Venice

Refurbishment of a 16th century Italian Renaissance architectural masterpiece. Detailed nonlinear FE analysis for seismic loads to minimize strengthening measures.

80%

Reduction of seismic retrofit costs



So across a wide range of areas, activities and project stages, we are seeing digital and AI solutions developed that can help design, build, manage, optimise and repurpose housing of different types, in a way we were not able to before

*Design for
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ARUP
80 YEARS

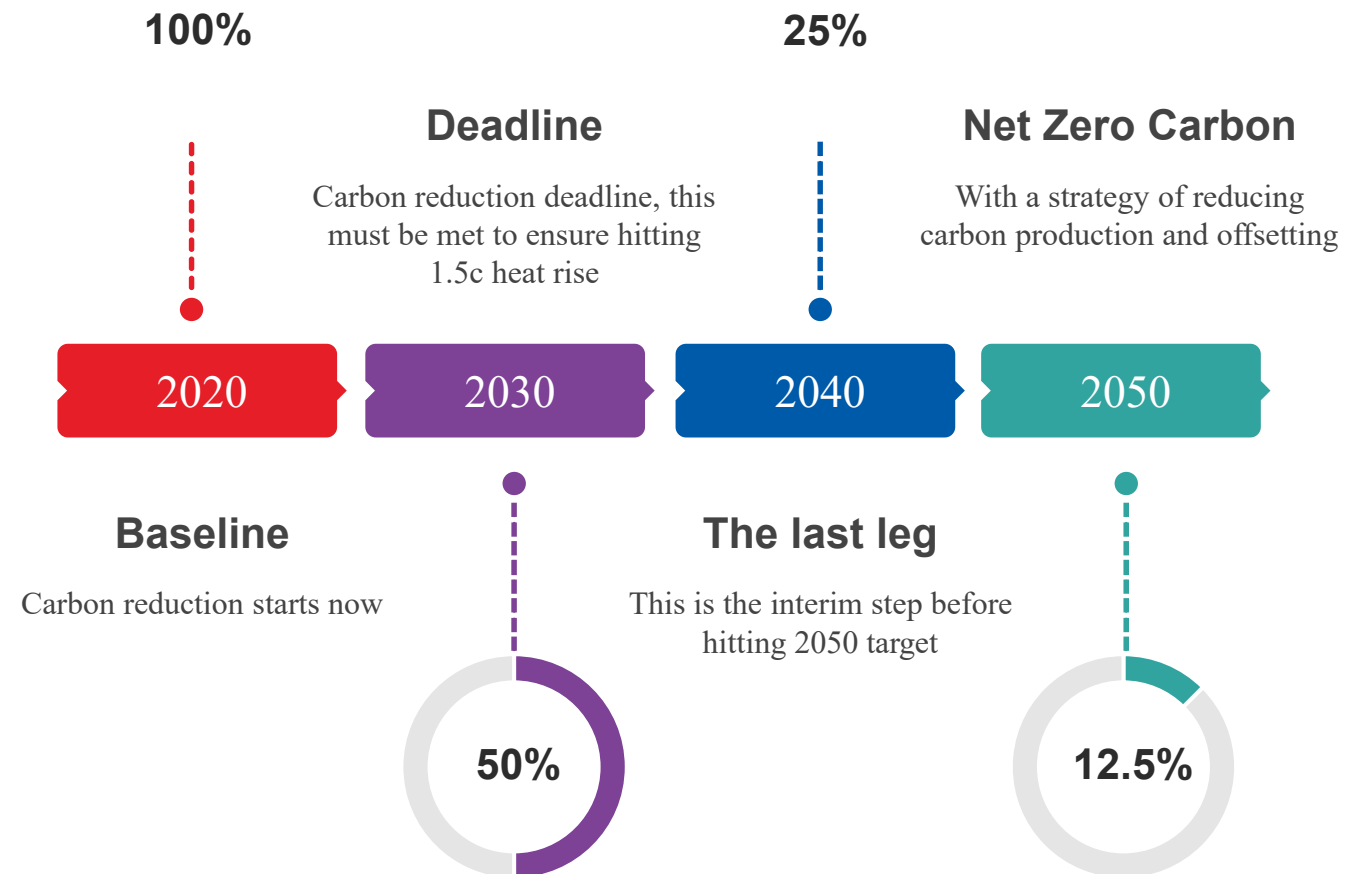
Quantifying Sustainability from Cost to ROI

Arup

Elaine Tan

Net Zero Timeline


To meet climate change goals of keeping below 2°C, a proposed halving of emissions every decade, known as ‘Carbon Law’, has been considered as one of the greater solutions.




Decarbonising Asia Pacific's Office Buildings

Higher Green Adoption as of Q2 2024


50.5% of total office space has acquired LEED or a local green certification

 **6.5%** year to year

Green Rental Premium

 Maximum **4%** of rental premium over non-green buildings

Higher Occupancy Rates

 **~2%** occupancy rate above non-green buildings

Markets with highest green adoption rate

1. Major Australian cities
2. Singapore
3. Tokyo

Markets with the largest green rental premium:

1. Mumbai
2. Hong Kong
3. Bangalore

Markets with the highest occupancy rate:

1. Seoul
2. Taipei
3. Singapore

Quantifying Sustainability

Beyond technical feasibility, the commercial sustainability and financing of green building has been one of the biggest challenges to adoption

The industry has been slow to embrace sustainability initiatives **because of the assumption that they are purely sources of additional costs, and reduce profits**



Cost of Green Building

It is undeniable that planning, building and operating a green building imply additional costs across the project lifecycle

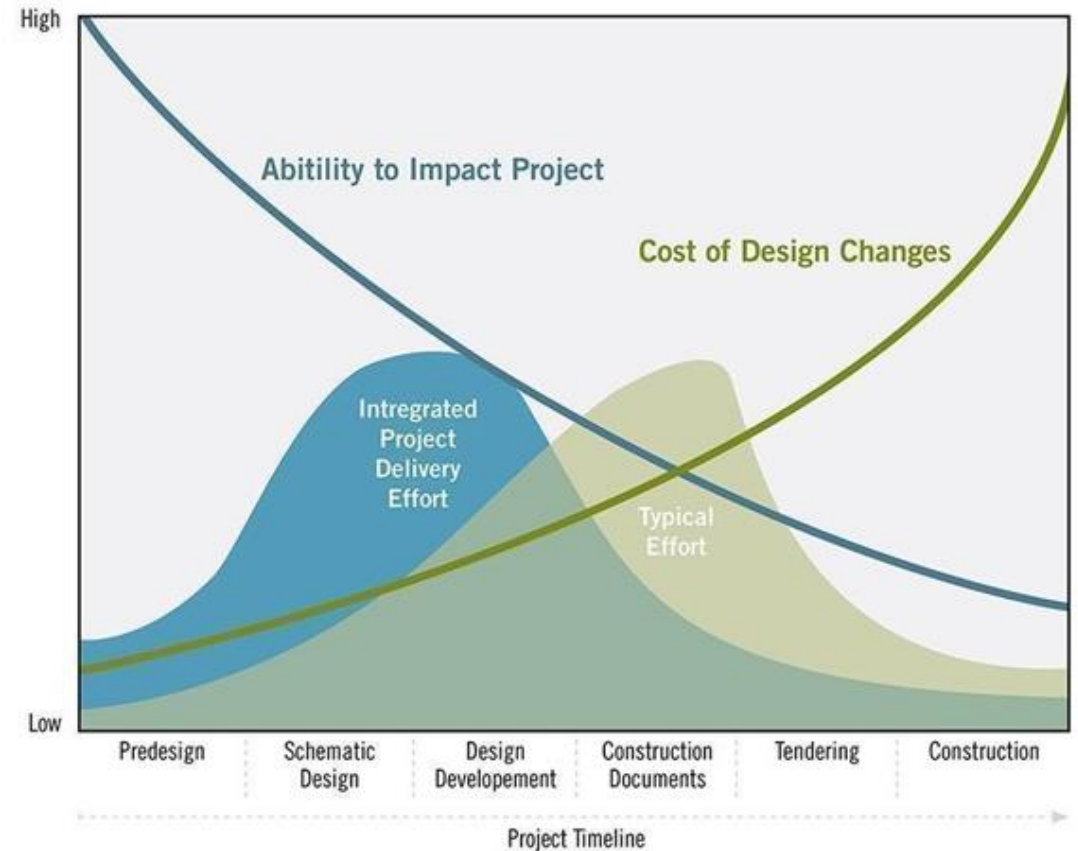
| Planning | Construction |
|---|--|
| <p>Planning & Design Costs More complex projects requiring new materials and technologies. As such needs specialist architects and engineers which are harder to find and in high demand, hence more expensive to hire</p> | <p>Construction + Fit Out Costs Extra costs coming from:</p> <ul style="list-style-type: none">• Sustainable HVAC system• Energy efficient lighting• Passive design elements• Superior insulation• On site renewable energy sources• And others <p>Depending on how many of these solutions a developer is implementing, as well as the specifications of the system, the costs could vary significantly</p> |
| <p>Certification Costs Cost of sustainability consultants and green building assessors, certification registration fee, service charge certification review fee, cost of appeal, enquiries and express certification fees</p> | |

Source: The Price of Innovation: An Analysis of the Marginal Cost of Green Buildings, based on a study of 336 BREEAM certified buildings

Cost of Change

Sustainability is cheapest at Concept Stage, and most expensive when introduced late

- **Early stage:** Low cost, high impact (orientation, massing, passive design)
- **Design stage:** Moderate cost to retrofit sustainability
- **Construction stage:** High cost (redesign, procurement changes)



From CAPEX to Service

In addition, new business models are reducing the total cost of ownership (TCO) of critical green building technologies

Cooling as a service

The provider owns the asset, maintains it and operates it



Put the burden of owning and operating to service provider, which incentives it to run it efficiently as a portfolio (implemented in Paya Lebar Quarter)

TCO Reduction

-20%

Energy Performance Contract

Allows funding energy upgrades from cost reductions

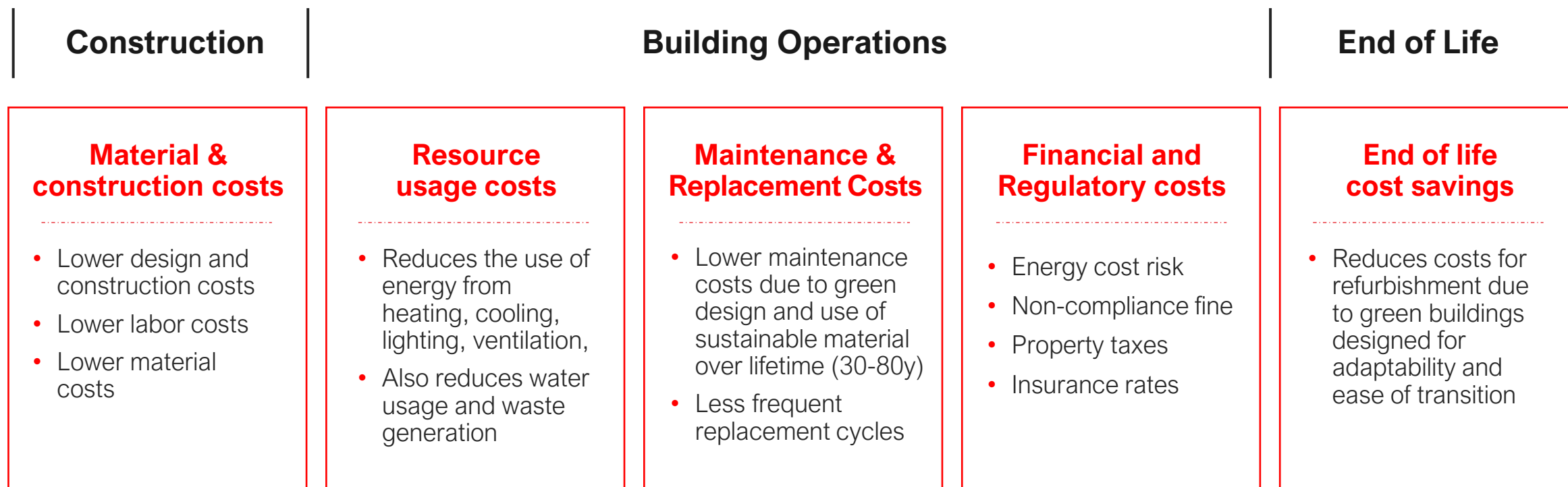


External organization implements an energy efficiency project and uses the income stream to repay the cost of the project and investment

Transfers the technical, performance and credit risk to a third party

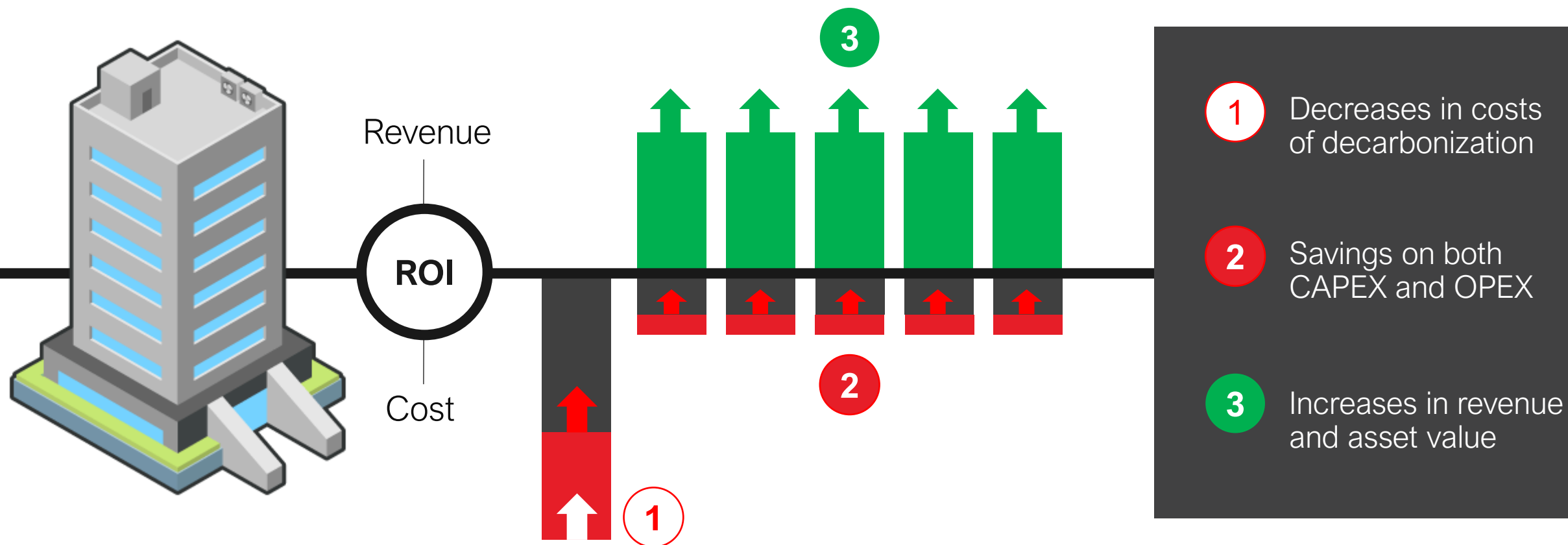
Cost Reduction Across the Building Lifecycle

While people tend to focus on energy cost reduction, the gamut of cost reduction driver is much wider than one typically imagines



ROI of Sustainability

Decarbonisation is often seen as a purely an added costs, but evolutions in three main aspects of the ROI equation are changing the value equation



Translating Cost to ROI

Overall, cost savings lead to positive ROI for typical initiatives and certifications

ROI of energy-efficient lighting systems
Short payback time of less than three years.

ROI of Intelligent building control systems
Short payback period of about over 6 months to 2 years

ROI of efficient air distribution systems
Short payback time of 12 to 18 months using energy efficient ventilation system (HVAC)

| Green Mark certification | Typical initiatives | Cost Premium | Payback Period |
|--------------------------|--|--------------|----------------|
| Gold+ | • LED lightings | 1% | 3 yrs |
| | • Energy saving appliances | ▼ | ▼ |
| Platinum | • Water-saving features | 2% | 6 yrs |
| | • Facades / insulation | ▼ | ▼ |
| | • Building management systems (BMS) | 2% | 4 yrs |
| SLE | • Efficient air distribution systems | 5% | 8 yrs |
| | • Renewable energy | 4% | 6 yrs |
| | • Smart lighting system | ▼ | ▼ |
| | • Intelligent building control systems | 8% | 12 yrs |
| | • Chiller plant efficiency | | |

Strong ROI is achievable, but depends on Context and Execution

A couple caveats come with these figures however (one bad, one good)

These figures use code compliant buildings in countries with certifications and strong green building councils

Countries whose building regulations do not reflect a similar emphasis on the green transitions might see bigger gaps between the cost of a code-compliant building and a green building

Several studies show that it is possible to reach cost parity, or even a cost discount

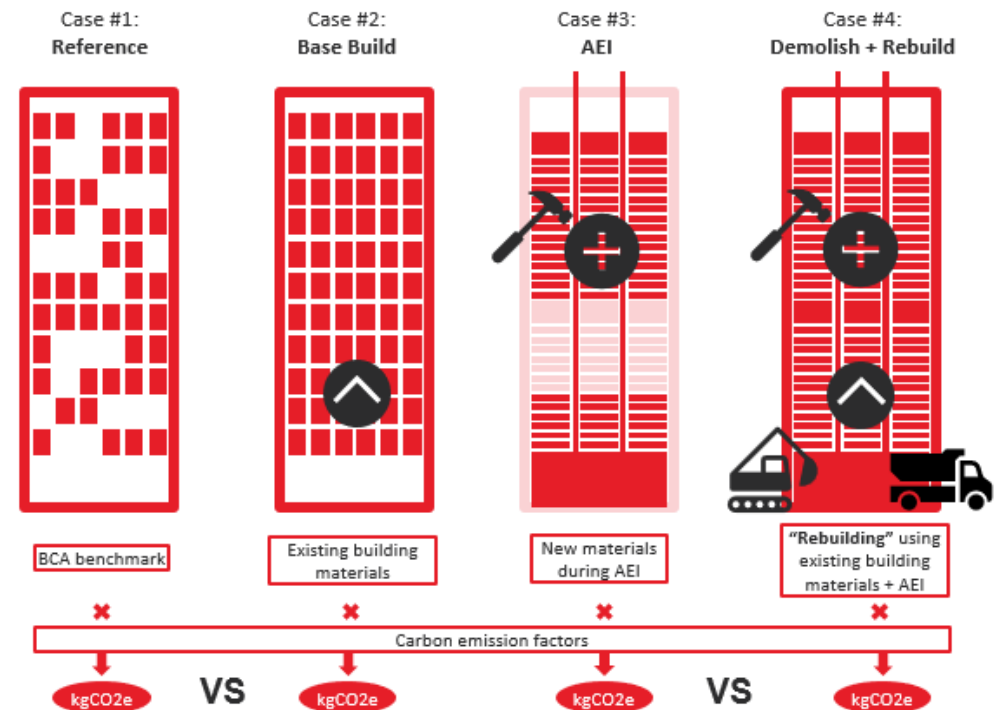
- Adopting green strategies early to avoid bolt on
- Hire experienced design and construction team
- Using integrated design processes

Real challenge is to shift mindsets from green building as bolt on towards integrated approaches

Case Study #1

Retrofit vs Rebuild

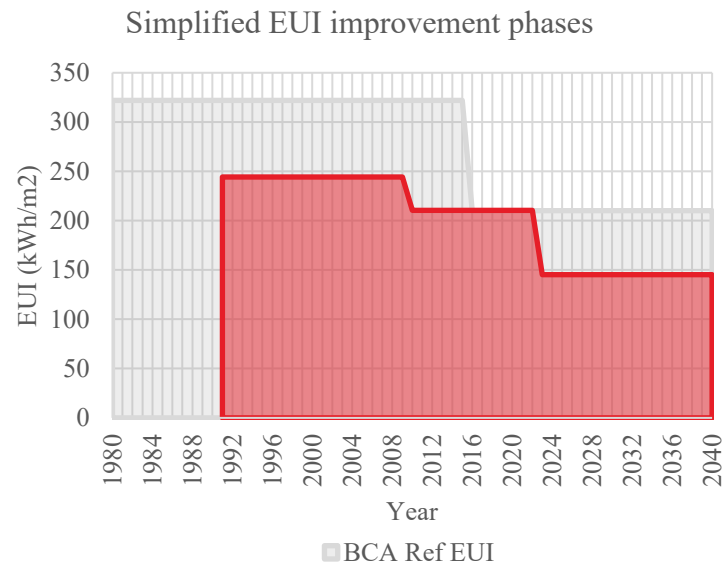
- Whole life carbon assessment of existing asset undergoing comprehensive asset enhancement initiative (AEI)
- To establish and compare the option of retrofit in comparison to a knock down and rebuild
 - To carry out embodied carbon assessment of AEI
 - To define, quantify and assess carbon emissions of buildings during construction, maintenance & operation stages
 - To explore and compare the results against benchmarks



Cost of Retrofit vs Rebuild

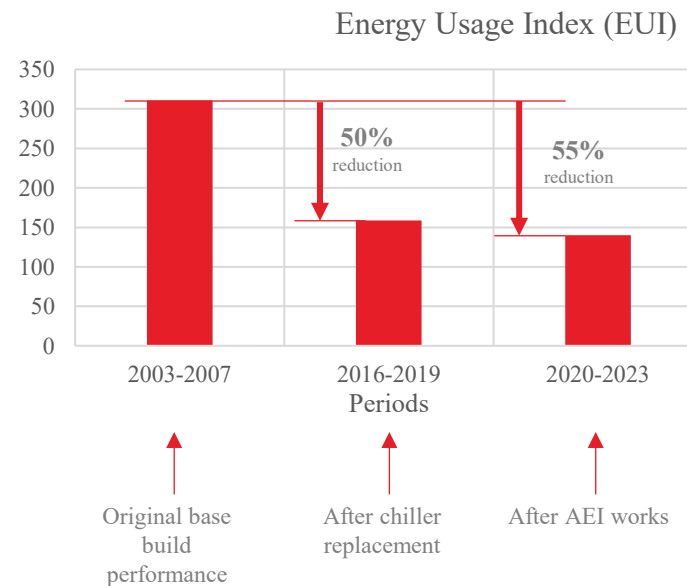
1 Your starting point matters

Poor design means more years of operating at higher costs.



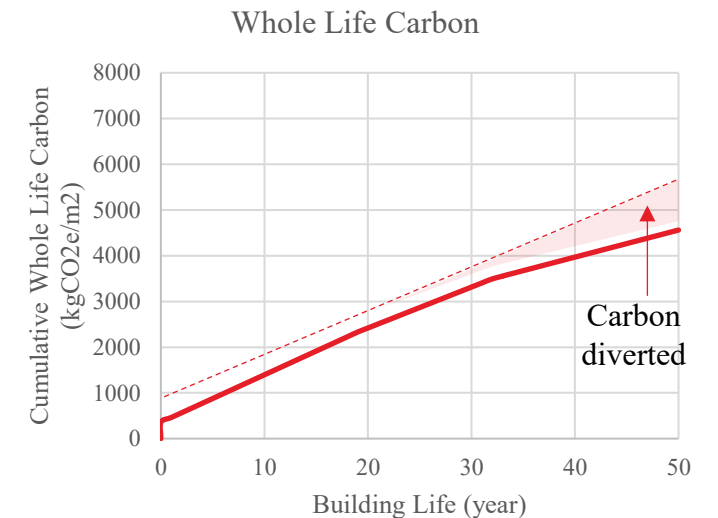
2 Biggest savings come from system improvement

Constantly reassess the need to improve your building's performance.



3 Your trajectory matters too

Constantly reassess the need to improve your building's performance.

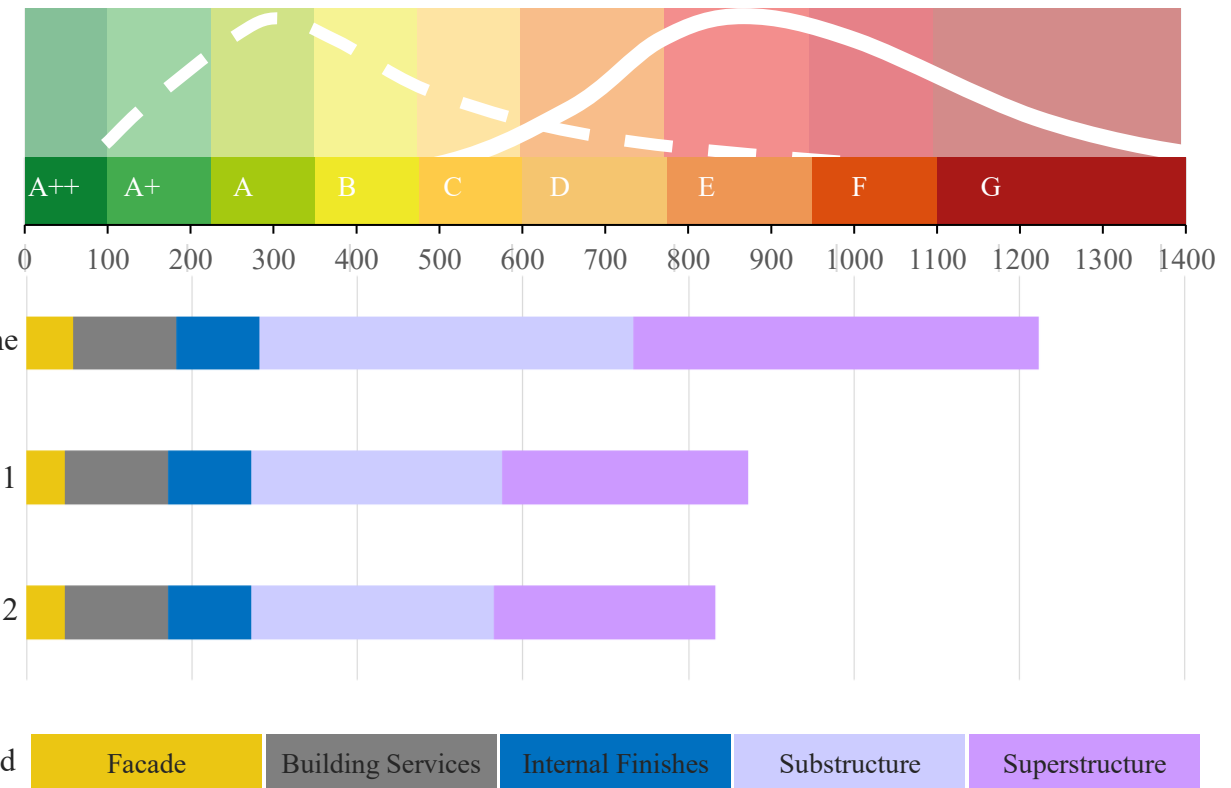


Case Study #2

New build

During concept design stage, focus on the product and construction (A1-A5 modules) of the Whole Life Carbon Assessment (WLCA) boundary.

Various scenarios have been studied and compared against one another to find understand the most carbon friendly design.



| Building Element | Base Case | Scenarios | | | | |
|------------------|-------------------------------|-------------------------------|-------------------------------|--------------------------|--------------------|--------------------|
| | | 1 | 2 | 3 | 4 | 5 |
| Substructure | General concrete | Green Concrete | Green Concrete | | | |
| | Structural steel | Structural steel | Recycled steel | | | |
| Superstructure | RC Slab + CLT + Smoke Curtain | RC Slab + CLT + Smoke Curtain | RC Slab + CLT + Smoke Curtain | CLT + Fire curtain | CLT + Fire curtain | CLT + Fire curtain |
| | General concrete | Green Concrete | Green Concrete | General concrete | Green Concrete | Green Concrete |
| | Structural steel | Structural steel | Recycled steel | Structural steel | Structural steel | Recycled steel |
| Façade | Glass - DGU | Glass - DGU / Laminated | Glass - DGU / Laminated | Glass - DGU / Laminated | | |
| | Fins - Ceramic | Fins - Ceramic | Fins - GFRC | Fins - GFRC | | |
| | Catwalk - Steel | Catwalk - Recycled Steel | Catwalk - Recycled Steel | Catwalk - Recycled Steel | | |

Delivering Cost Effective Sustainable Design

1 Market and policy strongly influence outcome

Cost gaps vary significantly depending on:

- Regulatory maturity and certification requirements
- Market readiness
- Supply chain capacity

2 Need to look beyond just environmental benefits

The decision ultimately hinges on a balanced evaluation of the unique advantages and challenges of each development option – considerations like

- Costs of upgrades (CAPEX, and impact on existing operations)
- Social benefits (revitalization of communities, health & wellbeing)
- Technical challenges (need to meet regulations)

3 Early integration is critical to achieving cost parity

Cost premiums are often driven by late-stage, bolt-on sustainability measurements. Integrated design from concept stage enables:

- Optimise system sizing
- Reduced duplications and inefficiencies
- Better coordination across teams

Case study #3

Portfolio

Which + When

Short Term: **2022** ⓘ

- Campus Electrification
- Renewable Energy On Campus
- Existing Building Upgrades
- Target Zero Waste Strategy
- Sustainable Transport Strategy
- Offset

\$0
Capex

Medium Term: **2025**

- Campus Electrification
- Renewable Energy On Campus
- Existing Building Upgrades
- Target Zero Waste Strategy
- Sustainable Transport Strategy
- Offset

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Long Term: **2030**

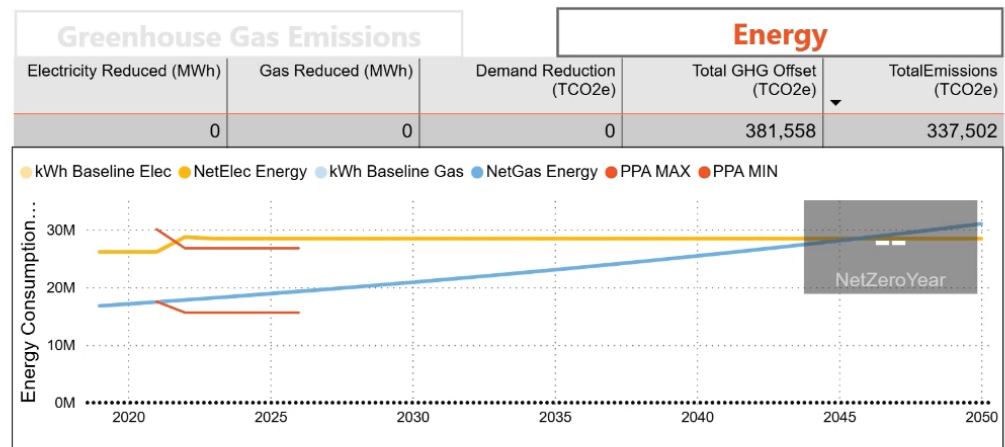
- Campus Electrification
- Renewable Energy On Campus
- Existing Building Upgrades
- Target Zero Waste Strategy
- Sustainable Transport Strategy
- Offset

\$0
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Version 2.3 NOV 2021

Currently planned | NetZero Plan | Reset

2030 Horizon
2050 Horizon



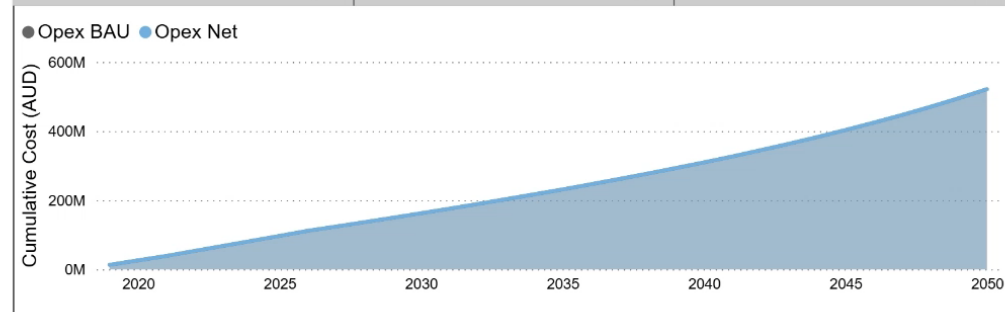
Carbon Offset Cost:

\$ 31 / TCO2e

PPA: The current power purchase agreement is in place from 2021. The contract price of \$0.45 kWh is contingent on min/max consumption limits. See energy graph for boundaries

Return on Investment

| Carbon Offset Costs | Projected Cost Savings: 2050 | BAU Cumulative Costs: 2050 |
|---------------------|------------------------------|----------------------------|
| \$0M | \$0M | \$521M |



Technology & Supply Chain

Not all cost reduction opportunities are created equal. Some are well established and well understood, while many others – still emerging – are up for debate

Mature

- Energy and water savings through efficient systems
- Lower operating and Maintenance costs due to overall efficient design of the green building



Emerging

- Sustainable materials like cross laminated timber (CLT)
- Recycled aggregate (RCA)
- Prefabricated Prefinished Volumetric Construction / Modular construction



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