ARUP

Annual Report 2021

Creating Sustainable Futures

arup.com/annual-report-2021

Our firm

Our work

Our vision

> “We are here to create a more sustainable future, balancing the needs of people, places and planet.”
>
> Alan Belfield, Chair

Creating Sustainable Futures is Arup’s strategy and purpose. It drives all work with our clients and the communities in which we are based and work. Arup’s members are determined to shape a better and more sustainable world - for all.

We recognise that creating real sustainable development requires combined economic, social, and environmental transformation on a global scale. Our contribution to making this transformation a reality is through our projects for clients. In this annual report we share examples of how our projects, designed and delivered on behalf of our clients and partners, are bringing sustainable development to life around the world.

To deliver on our sustainable development purpose, we announced two important decarbonisation commitments at the UN climate change conference, COP26: one is focused on our energy sector work and the other on our sustainable approach to building design. These commitments take us beyond simply reducing our own Scope 1–3 greenhouse gas emissions to achieve net zero by 2030 and into the wider world of how we deliver our work for clients.

Our decarbonisation commitments ↗

Alan Belfield, Chair

A challenging, yet inspiring year

View immersive experience ↗

While this year was an extremely challenging one, it was also an inspiring year. We've worked on some fantastic projects, served our clients well in difficult times and continued to win new work.

It's been incredible to observe what our members have managed to achieve, despite the COVID-19 pandemic and with three quarters of our people working from home. I couldn't be prouder of the commitment and dedication that everyone has shown.

Robust performance

Despite the shock to the global economy, we delivered a strong performance for the financial year ending 31 March 2021. Our revenue was £1.717bn, similar to the year before, and we returned a profit of 10% (before the application of the global profit-share scheme), which reflects the substantial effort made by everyone in the firm to maintain our operations through the pandemic. Notwithstanding the short-term uncertainty as the pandemic took hold, our continued focus on winning new work and supporting our clients across the business means we are in a strong commercial position for the road ahead. While the world's responses to the pandemic had major impacts on some of our businesses like aviation, other areas, such as science, industry and technology, and healthcare grew during the year.

75th Anniversary

In 2021, we passed a significant milestone: it was 75 years ago that Ove Arup founded the firm. Since then, we have grown and thrived by doing high-quality work and staying true to the aims and values he identified as central to who we are.

Ove believed in ‘total design’ and we still believe in that today. In a rapidly changing and complex world, only the widest cooperation can solve the big issues the world faces around climate change and resilience. Although he wouldn’t recognise the digital tools we now use, Ove would be familiar with how we’re trying to influence the world, and the underlying spirit and the creativity that we bring to our projects. He observed that our work must be excellent and socially useful and, as we carry it out, we need to be straight and honourable in our dealings.

I think we are all thankful that he gifted us an organisational structure, a mission and an independence that is as relevant today as 75 years ago.

Sustainable futures

Clarity and direction are incredibly valuable in a crisis. So, in July 2020, we launched Sustainable futures – a new three-year strategy with sustainable development at its heart. It positions us to have a more positive impact on the built environment than ever before – to create a greener, cleaner, fairer and more sustainable society. The strategy now guides the choices that we make and the projects we pursue.

The big drivers for change continue to be around urbanisation, population growth, climate change and scarcity of resources. The pandemic has brought a renewed and vital focus on city resilience and the need to act on climate change.

Our clients are increasingly engaging with the urgency of climate action and the scale of change required to achieve net-zero emissions globally by 2050. Our advisory role has also grown, from services like sustainable investment consulting, through to helping clients get ready for the EU Taxonomy for sustainable economic activities.

Partnerships are incredibly important to the way we work and the influence we can have. In 2020, we were commissioned by the UK Government to carry out the sustainability advisory work for the G7 and COP26 summits. We are working more and more on energy transition, including the use of hydrogen, on the circularity of materials and are helping the World Economic Forum to develop their thinking in these areas. We are promoting circular economy principles throughout our industry, working with the Mayors Alliance for the European Green Deal and with the Ellen MacArthur Foundation.

Across Arup, we have a growing community of experts with the skills and knowledge to tackle these issues. We remain committed to using our influence to lead the debate and establish more sustainable practices.

A better way

The effects of climate change and the impact of the COVID-19 pandemic has highlighted the increasing importance of resilience – to improve cities' and communities' ability to adapt to rapidly changing circumstances and increasing risk. There is a better way to a sustainable future. Our focus is to use our design and advisory services to produce safer, more inclusive, resilient and sustainable cities and infrastructure.

Much of our current work points to the sustainable world we want to see. We're delighted to be working on the design of 1,000 hectares of artificial islands in Hong Kong as part of the Lantau Tomorrow Vision, proposed to meet the long-term housing, social and economic development needs of Hong Kong.

We deliver high-quality work and build long-term trusted relationships with our clients and collaborators in all our markets. One example of this ongoing collaborative work is with Transport Infrastructure Ireland where we've helped craft a sustainability strategy for the entire organisation to truly help embed the agenda culturally. We also undertook research into women's travel patterns to inform decisions by the state agency that deals with road and public transport on how sustainable transport modes can become a viable option for all members of society.

Architecture is increasingly important for us, giving us more influence and is very much part of our total design ethos. This can be seen clearly at London's 1 Triton Square, where we used circular economy principles to refurbish a major commercial building, significantly reducing embodied carbon across its lifespan.

With 15% of all North American container traffic due to cross over California's first long-span cable-stayed bridge, the Gerald Desmond Bridge is a critical infrastructure link and a vital component of the regional and national economy. The new bridge opened in October 2020 to serve the needs of a growing region and ensure the safe, optimised flow of people and goods, with truck-climbing lanes and shoulders on both sides of the highway leading to reduced congestion.

Our City Modelling Lab brings together our experts in transport, energy, climate change and economics with data scientists, software engineers and designers to help transport and planning authorities anticipate demand on their travel networks and shape investment.

We are working with Transport for London as its agent-based modelling partner at a city scale, and for New Zealand's Ministry for Transport, where we are not only building a national-scale model for the next 50 years but developing the Ministry's own ability to create, run and model future scenarios.

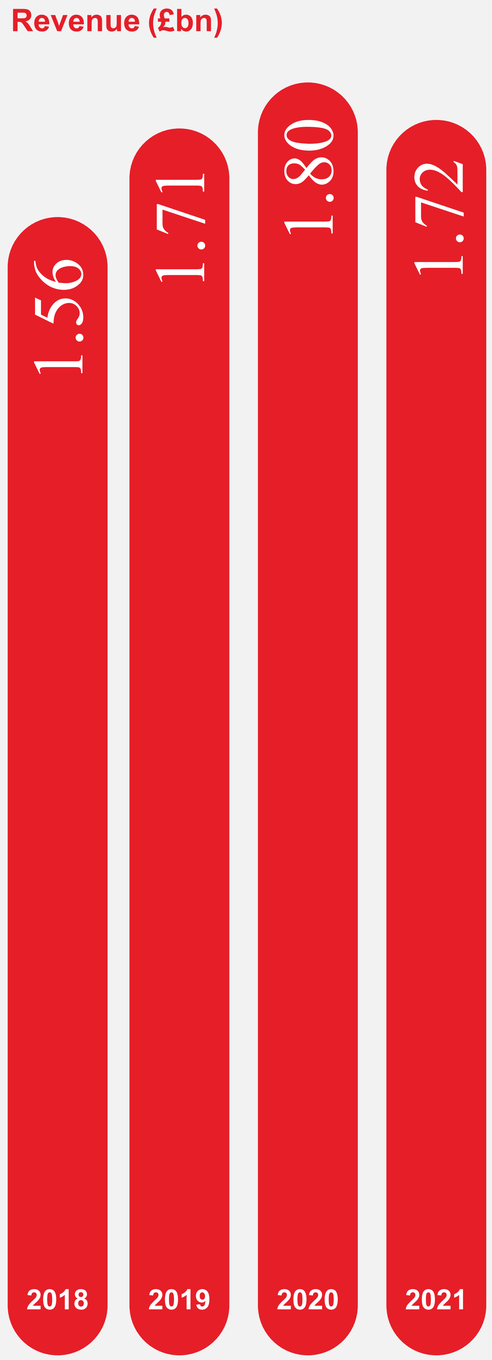
Flexible working

The last year has demonstrated how we can both work flexibly and continue to deliver excellent work for our clients. Many of us have missed the collaboration and creativity that comes from working side by side, while technology has enabled us to work with each other in new ways at greater distances. We want to combine the best of these experiences, so as the pandemic recedes, we are committed to operating a flexible workplace, one that attracts, develops and keeps the best talent here at Arup while supporting their wellbeing. I am really proud of our members and the way we've performed over the last 12 months. Our strong performance gives us a solid platform to build on for the year ahead.

Alan Belfield
Chair

Governance ↗

Our performance



10% **Profit**

£1.3bn **Forward order book**

Financial summary

In this financial year, Arup delivered a strong performance with our revenue at £1.72bn, similar to the previous year, with an operating profit (before staff-profit sharing) of 10%.

This was a considerable achievement in a very difficult period when COVID-19 had a major impact on our operations, our clients and the economies in which we operate in. The pandemic affected some areas of our business such as aviation, but other areas grew including government and healthcare work.

Steps were taken early in the year to introduce various cash conservation measures and unfortunately we had to reduce our staff numbers.

Capital expenditure was reduced, pay rises were delayed and we benefited from a large reduction in business travel costs. We also placed an increased focus on cash collection, working with our clients and suppliers to convert cash efficiently and to pay it out in a timely manner.

These actions have made sure that, overall, we have a very positive cash position – enabling the firm to deal with any shocks to the business resulting from the impacts of the pandemic.

A strong second half of the year saw staff numbers return close to the levels of March 2020, with our forward order book at £1.3bn – the same level as 12 months previously.

Across each of our five Regions we performed well, particularly in East Asia, which was a strong growth area. This has left us in solid commercial position with a return to modest growth expected this year.

Rob Boardman
Chief Financial Officer

At a glance

16,000 Members

6,800 Clients

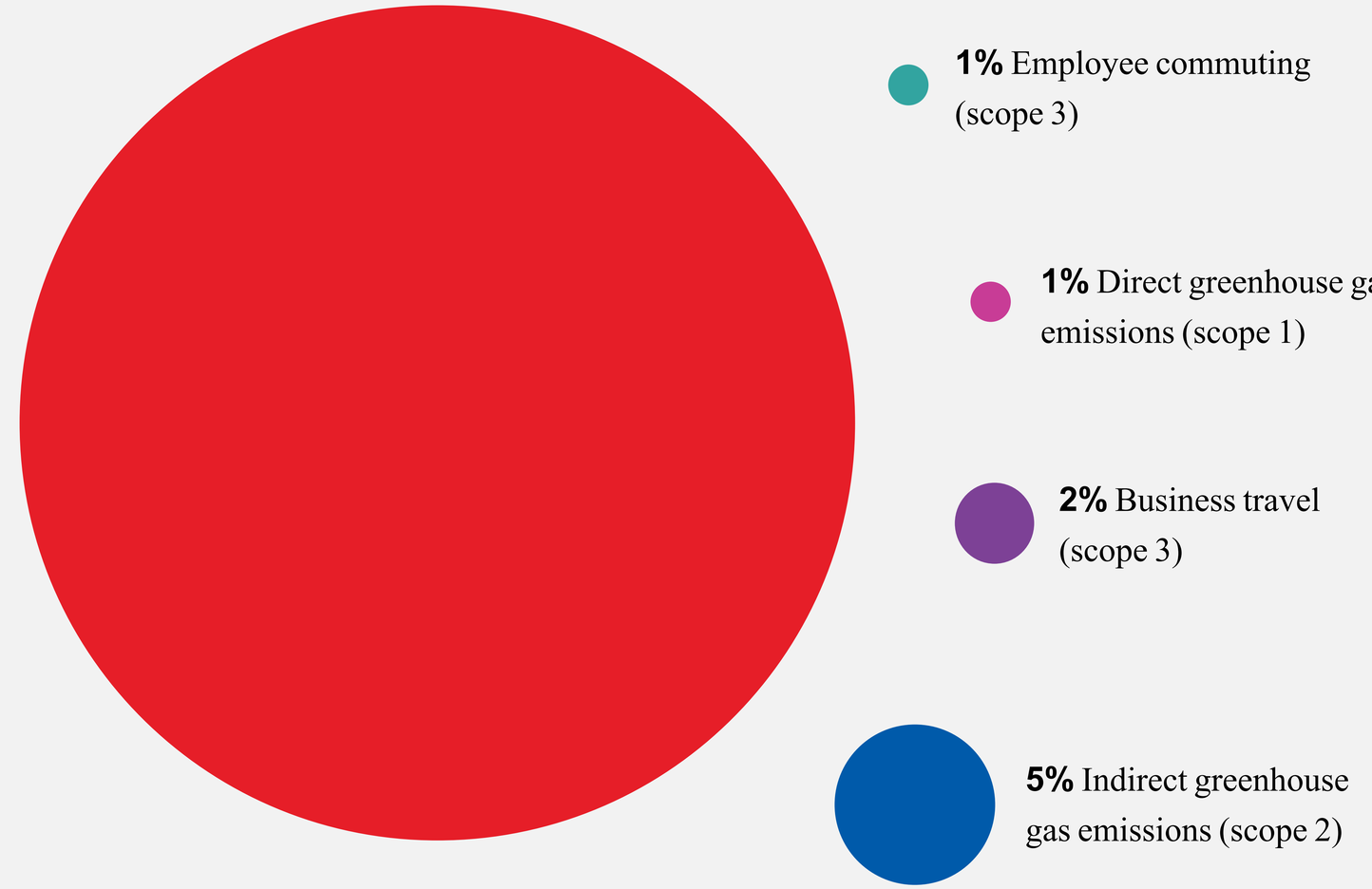
150 Countries

A breakdown of our global carbon footprint

123,301 **Tonnes of CO_2**

–39% **From 2020 CO_2 emissions**

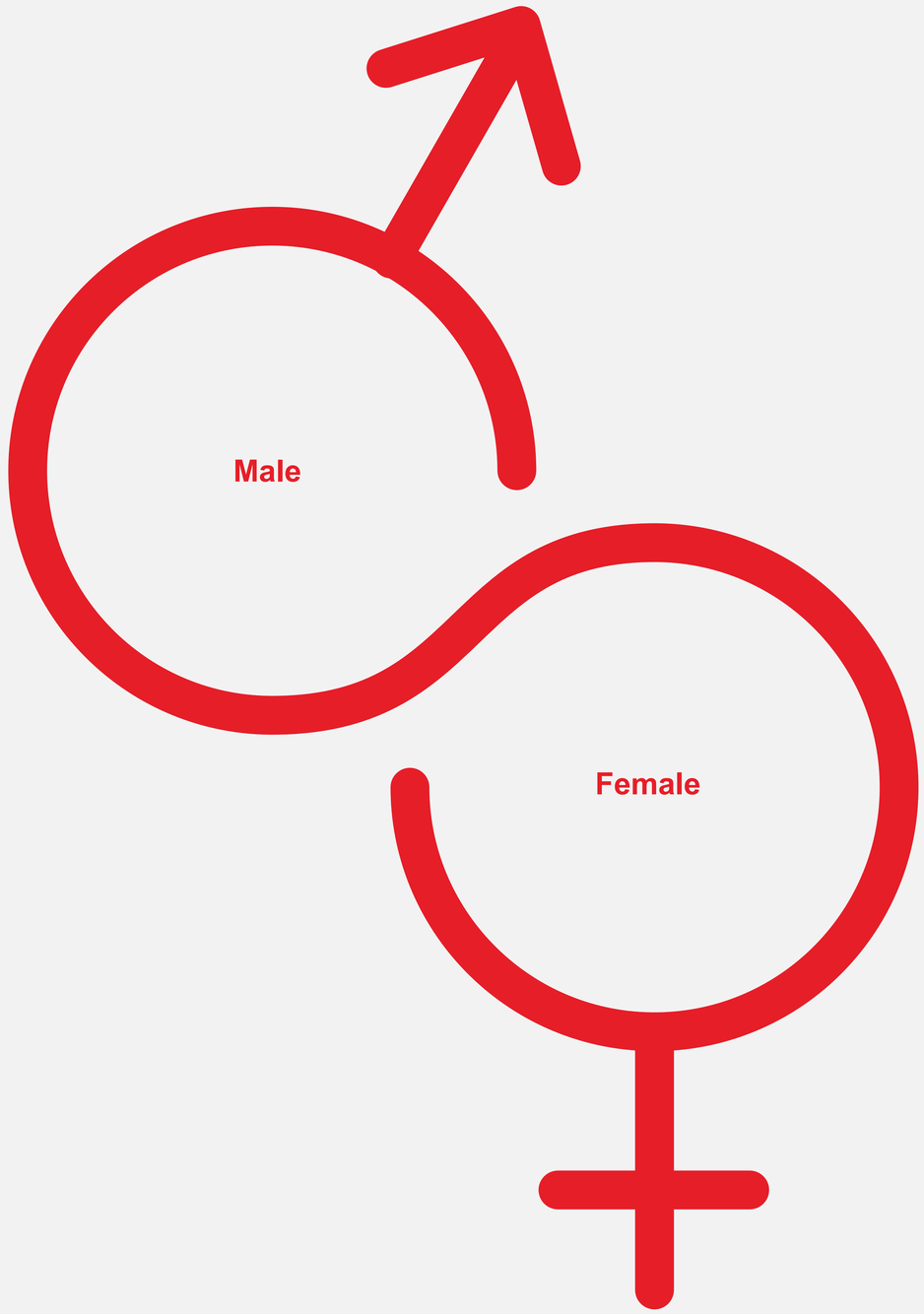
View Arup's net zero strategy ↗



Gender balance

62%
Full membership

75%
Leadership



38%
Full membership

25%
Leadership

Arup's contributions to community engagement projects

41,000 Hours of work from Arup members

1,070 Arup members who have contributed

200 Projects delivered

40 Countries worked in

Supporting communities

Climate change hits the world's most vulnerable people and communities the hardest. Our members commit their time and expertise to helping communities build resilience to the climate crisis, COVID-19 and to address long-standing challenges of equity and access. Our recent community engagement work has included a focus on sustainable housing and supporting young women to develop their knowledge and passion for science, technology, engineering and mathematics (STEM).

Million Cool Roofs Challenge, Mexico ↗
Proving the value of passive cooling techniques

Resilient housing for the underprivileged, Philippines ↗
Storm-resistant housing design for rural communities

Solar Air Conditioning Sizing Tool ↗
Digital tools used to accelerate
solar-powered air conditioning

Olkola Knowledge Centre, Australia ↗
Building collective knowledge in
low-impact, low-carbon construction

I Wish, Ireland ↗
Inspiring young women to
pursue careers in STEM

Project awards

Australia

100 Mount Street, Sydney
Council on Tall Buildings and Urban Habitat
Overall Innovation Award for Baker Brace

Australian National University Acton Campus Master Plan
Australian Urban Design Awards
Leadership Advocacy and Research: Local and Neighbourhood Scale

Electronic Danger Tag, Sydney
Australasian Railway Association
Australasia Rail Industry Awards – Innovation and Technology

Haughton River Floodplain Upgrade Design Project, Queensland
Infrastructure Partnerships Australia
National Infrastructure Awards – Innovation & Excellence

Macquarie University Ainsworth Building, Sydney
Australian Timber Design Awards
People's Choice

Making cities safer for girls and women with light
Consult Australia
Awards for Excellence – Community Engagement Excellence – Gold Award

Consult Australia Awards for Excellence
Large Firm of the Year - Arup

Colombia

Atrio North Tower, Bogota
Council on Tall Buildings and Urban Habitat
Best Tall Building 200-299 metres – Audience Winner
Best Tall Office Building – Winner

China

Development of a Common Spatial Data Infrastructure – Built Environment Application Platform, Hong Kong
International Data Corporation Smart City Asia Pacific Awards
Urban Planning and Land Use – Winner

International Society for City and Regional Planners Awards for Excellence
Grand Award

Central Market Revitalisation project, Hong Kong
Hong Kong Institute of Engineers Structural Excellence Award
Heritage category – Grand Award

CITIC Tower, Beijing
Council on Tall Buildings and Urban Habitat Annual Awards
Best Tall Building (400 meters and above) – Overall Winner
Fire & Risk Engineering – Overall Winnerr

Neuron, Hong Kong
Hong Kong ICT Awards
Smart Business Award (Big Data and Open Data Application) – Gold Award

Construction Industry Council – BIM Achievement

Raffles City Chongqing
Council on Tall Buildings and Urban Habitat Annual Awards
Best Tall Building 300-400 meters – Overall and Audience Winner

Denmark

Orientkaj Station, Copenhagen
Sustainable Concrete Award

Ireland

Engineers Ireland
Continuing Professional Development Company of the Year – Arup

Miesian Plaza, Dublin
Association of Consulting Engineers of Ireland
Climate Change Adaptation Category

Rose Fitzgerald Kennedy Bridge
International Association of Bridge and Structural Engineering
Outstanding Structure Award (Bridge/Infrastructure)

Korea

Amorepacific Corporation Headquarters, Seoul
Chartered Institute of Building Services Engineers
Building Performance Awards
Climate Commercial/Industrial – Project of the Year

Singapore

Outram Community Hospital
Building and Construction Authority
Design and Engineering Safety Awards – Institutional and Industrial category Excellence Award

Thomson-East Coast Line, Woodlands Station
Building and Construction Authority
Design and Engineering Safety Awards – Civil and Structural Category Excellence Award

Spain

Méndez Álvaro II Complex, Madrid
Casos de Éxito en Project Management
Aedip (Asociación Española de Dirección Integrada de Proyecto)

UK

1 Triton Square, London
BREEAM Awards
BREEAM Commercial Projects – Design award

Baggage Safety & Welfare BC6315, Heathrow Airport
Association for Business Psychology
Excellence in Engagement and Employee Experience

Keyn Glas – Highways England Environmental Designated Funds
Landscape Institute
Sir David Attenborough Award for Enhancing Biodiversity

University of Sheffield – Concourse lighting
International Association of Lighting Designers
Radiance Award

Urban Childhoods, Belfast City Centre
Landscape Institute
Excellence in Place Regeneration Award

WaterUp
Flood and Coast Excellence Awards
Community Partnerships category

USA

Alaska Airlines Flagship Lounge, Seatac, Washington
Architizer Aplus Awards
Transportation – Transport Interiors – Popular Choice Winner

American Productivity and Quality Center
Excellence in Knowledge Management Award – Arup

Kaiser Permanente Bernard J. Tyson School of Medicine, California
Rethinking the Future Awards
Institutional (Built) category

Nohona Hale, Hawaii
US Green Building Council
Best of Building Awards
Leadership Award

P3 Awards
Technical Advisor of the Year
Gold Award – Arup

People awards

Adele Carey
Laura Frost
Ritu Garg
Martha Hart
Jennifer Kelly
Clare Lavelle
Women's Engineering Society
Top 50 Women in Engineering Award – Sustainability

Fu Chuanming
Association of Consulting Engineers Singapore
Young Consulting Engineer of the Year – Mechanical Category

Dan Clipsom
UK IT Industry Awards
Business Analyst of the Year

Jo da Silva
Sovereign of the United Kingdom
Dame Commander of the Order of the British Empire

Peter Debney
Institution of Structural Engineers
Lewis Kent Award

Louise Ellis
Management Consultancies Association
Thought Leader Consultant of the Year Award

The Times
Consultant of the Year

Heidi Genoni
World Hydrogen Awards
Woman in Hydrogen

Ray Grill
Siemens Leadership Award

Naeem Hussain
Fellowship Royal Academy of Engineering Academy

Samantha Kong
Institution of Engineering and Technology Hong Kong
Young Woman Engineer of the Year Award

Florence Lam
Society of Light and Lighting
President's Medal

Zishu Liu
European Transport Conference
Neil Mansfield Award

Kate Lodge
Chartered Institution of Highways and Transportation
Young Professional of the Year

Dervilla Mitchell
Royal Academy of Engineering
President's Medal

Sowmya Parthasarathy
Chloe Salisbury
Royal Town Planning Institute
The Planner's Women of Influence list 2021 – Private Sector

Selina Rai
Institution of Civil Engineers
International Emerging Engineers Award

Scott Rathie
Engineers Australia
Australia's Most Innovative Engineers – Building and Construction category

Alex Rosenthal
Haico Schepers
Green Building Council of Australia
2021 Green Star Champions

Alistair Sargeant
Association of Consulting Engineers Singapore
Young Consulting Engineer of the Year – Civil & Structural Category

Hiba Abo Slo
BAME Apprenticeship Awards
Transport and Logistics
Apprentice of the Year

Anna Squire
Infrastructure Partnerships Australia
National Infrastructure Awards – Women's Achievement in Infrastructure Award

Yoong Heng Tan
Building and Construction Authority
Design and Engineering Safety Awards – Excellence Award

Dr Mushfika Upama
Railway Technical Society of Australasia
Graduate Railway Engineer

Stephanie Welch
Institute of Workplace and Facilities Management
Impact Awards – Manager of the Year

Philip Yeung
The Chartered Institute of Logistics and Transport Hong Kong
Young Achiever of the Year

Mycelium Floating Wetlands, Australia

Finding the solution in nature

View immersive experience ↗

Alessandro Liuti
Research Manager, Arup University

World-first innovation in biomaterials that could lead the way towards a waste-free future.

From polluting plastic to restorative fungi

Wetlands are an ecological marvel. They improve water quality, protect against floods and act as habitats for a rich range of species, many of which are rare. Yet unsustainable development and increasing levels of pollution have destroyed more than a third of the world's wetlands in the past 50 years. Attempts are being made to restore these valuable environments, but the plastic involved often creates more waste and pollution.

We are part of a groundbreaking project that uses mycelium – the roots of fungi – to replace plastic, providing a natural and biodegradable material that has had impressive results in an Australian wetland restoration pilot project.

Award-winning experimentation

Arup experts have been exploring mycelium's potential for almost a decade and, in 2014, we were the structural engineers for a 'mushroom tower' that used it as an alternative to traditional building bricks.

More recently, our Melbourne team has collaborated with Swinburne University of Technology to explore the concept of floating mycelium wetlands, a design developed by local designers studio edwards. We shared our international experience of working with mycelium to create and then test living prototypes in this world-first project, which won the gold prize for design research at the prestigious 2021 Australian Good Design Awards.

Restoring nature with nature

Named Mushi, the product is created by blending fungi spores with waste – in this case sawdust – and pouring into a mould. Over 10 to 20 days, the fungi grow and digest the waste sawdust, creating a strong, lightweight, non-toxic and totally biodegradable material.

Three prototype wetland restoration pods made from mycelium have been trialled in the Royal Botanic Gardens Victoria, with impressive results. Plants grew stronger and more healthily from the Mushi than they did from plastic wetland alternatives. The plant roots were also able to burrow through the pods, reaching the water below and allowing the plants to purify the water naturally.

Creative engineering

The vision now is to "turn a world-first into an industry-first" explains Alessandro Liuti, our Research Manager in Australia. "Arup's attitude to innovation allows you to see the potential in something and to make the case to pursue it, even if it seems like quite a distant goal." Alessandro is confident that biomaterial like mycelium will become viable option for designers working across the built environment.

What next for mycelium?

Arup designers in Europe have also been developing another use for mycelium – acoustic panels that function as biodegradable soundproofing or as an interior design feature. We used it ourselves as a low-impact, lightweight element of our stand at the 2021 UN climate change conference, COP26.

Back in Australia, the team that created Mushi is in discussions with water authorities about additional wetlands experimentation, potentially inspiring local communities to become involved in the simple manufacturing process. If Mushi fulfils its potential, the dream of removing plastic from wetland restoration could take a major step forward.

"Mycelium ticks all the boxes for sustainability, regenerative design and reducing our carbon footprint, and it has the potential to engage local communities."

Alessandro Liuti
Research Manager, Arup University

Bradley Plaza Green Alley, USA ↗
Good design, flood prevention and natural cooling revitalise an underutilised route

Reworking our urban food ecosystems for city-wide resilience, Singapore ↗
Circular economy design creates a foundation for sustainable food networks

Chongqing sustainable water masterplan, China ↗
Protecting a growing region from flooding and water pollution

Cliffs of Moher geohazard assessment, Ireland ↗
Using digital tools to scan towering ocean cliffs for erosion risks

Scottish Hydrogen Assessment, Scotland

Decarbonising to achieve net-zero

View immersive experience ↗

Clare Lavelle
Energy Consultancy Leader

Helping transition the world to affordable clean energy while creating a sustainable economic future.

Decarbonising the world

The world is racing to prevent extreme climate change, with nations setting net-zero targets to force the pace of decarbonisation. Relying on fossil fuels like oil, gas and coal, which release greenhouse gases into the atmosphere, cannot continue – we need to transform how we generate energy and power.

This global energy transition is fundamental to achieving ambitious national net-zero targets. We are working with governments on planning and implementing strategies that will help build a sustainable future through clean, zero-carbon energy.

What role for hydrogen in Scotland's future?

The oil and gas sector has been a driving force of the Scottish economy for 50 years, currently contributing approximately 10% of its GDP. But Scotland has an abundance of renewable resources too, with 97% of today's domestic electricity supplied by renewables – mainly wind and hydropower.

The Scottish Government commissioned Arup to assess the energy sector's current mix of fossil fuels and renewables and the role hydrogen could play in a net-zero future.

A net-zero gameplan

Working with consultancy E4tech, we explored how hydrogen could help Scotland reach its net-zero target by 2045 while at the same time creating jobs and contributing to economic growth. Our team included experts in clean energy markets, economics and regulation, technology and innovation. Our findings and recommendations were instrumental in shaping the Scottish Government's Hydrogen Policy Statement and the draft Hydrogen Action Plan.

Mix it up

There is much debate about the optimal design of next-generation national and regional energy systems and, according to Clare Lavelle, Arup's Energy Consultancy Leader in Scotland, there is no silver-bullet solution. "An energy system should be diverse, with multiple solutions driving decarbonisation. Hydrogen is part of the solution for applications that cannot easily be decarbonised through electrification. Hydrogen also complements electrification by increasing system resilience," she says. "If we get the mix right, we can design a system that's more efficient and resilient, and that creates economic opportunities."

Scenarios for a green future

Our role in the Scottish Hydrogen Assessment Project included supporting senior government decision makers to explore the role hydrogen could play in decarbonising the existing energy system.

During months of extensive analysis and consultation with stakeholders, we examined three scenarios for the future. The first envisaged using hydrogen extensively throughout the energy network, powering transport, providing heat and supplying industry. The second focused solely on production of green hydrogen from an expanding number of offshore wind farms in Scottish waters, then exporting to EU nations. The third looked at the use of hydrogen for difficult-to-decarbonise areas, including industrial heat and powering heavy goods vehicles.

A bold commitment

Each scenario would require radical changes to the existing energy sector and supply chain. The most ambitious would establish Scotland as the leading exporter of green hydrogen within Europe, with a potential economic value of £25bn and the creation of 300,000 jobs by 2045.

Following our analysis, the Scottish Government has been bold, setting a goal of 5GW installed hydrogen capacity by 2030 – one of the world's most ambitious goals to date. We continue to work with them on this policy, and advising on ways to educate and inspire people to embrace an energy transition that includes hydrogen.

A world of opportunity

Alongside our work in Scotland, we have also been commissioned by the Australian Government to analyse the potential for hydrogen in its energy transition, and we are advising on similar issues in South East Asia, Europe and England.

For David Hogg, one of our senior energy systems consultants based in Scotland, hydrogen is just one piece of the energy-sector puzzle. He is equally excited about our projects with other renewables, including work on floating offshore wind technology. There is a great deal of change ahead, but one thing is crystal clear – the future is net-zero.

"The strength of commitment that came out of the Scottish Government to adopt the 5GW target following our work was really exciting to see."

Clare Lavelle

Energy Consultancy Leader

£25bn Potential generation per year

300k Potential jobs

Convex, UK ↗
A digital tool to reduce the cost of wave-energy production

Welsh Government Electric Vehicle (EV) Charging Strategy, UK ↗
Electric vehicle charging infrastructure to accelerate net-zero progress

Ankara Cycling Strategy and Masterplan, Turkey ↗
Tackling air pollution, noise and congestion with cycling for all

Lower Hudson Transit Link, USA ↗
Resilient public transport for commuters in the Greater New York area

Green Mobility Study, Cambodia and Laos

Designing green and resilient futures

View immersive experience ↗

Corey Wong
Associate Director, Transport Consulting

Protecting and preserving World Heritage sites while fighting pollution.

Environmental action at a city scale

UNESCO World Heritage sites across Asia are increasingly affected by pollution damage. The World Bank commissioned us to develop plans for greener transport systems for two cities with historic sites: one in Laos and one in Cambodia.

The aim of this analytical work is to catalyse a major shift in the cities' transport cultures and dramatically improve people's health and wellbeing.

Impact on economies and heritage

Luang Prabang in Lao People's Democratic Republic and Siem Reap in Cambodia are both global tourist destinations, attracting nearly one million and more than four million annual tourists respectively, and contributing significantly to their nations' economies. Yet the impact of visitors is taking a toll on infrastructure and communities. With little-to-no public transport and around 80 per cent of the population of both cities relying on loud and dirty motorbikes, pollution levels are worsening and creating health risks. Increasing emissions are also damaging the monuments people flock to see.

Redirecting the future of travel

Following extensive study, our team has proposed major changes to how local people and tourists travel within these cities. As well as considering electric buses and new cycle networks, we have outlined improvements to pavements and the street environment that are designed to make walking far safer and more desirable.

A proposed package of investment for each city – alongside better zoning and improved enforcement of regulations to prevent illegal parking – will safeguard people's health as well as protect the heritage sites from more environmental damage.

A new way of thinking

"We've run workshops to understand the needs and priorities of disadvantaged groups," explains Corey Wong, the project's leader and an associate director in Arup's East Asia transport consulting team. "We will soon hold training sessions with local universities to inspire them to shift their mentality and change how they travel."

"We've also led training workshops with national and local government officials, working directly with those who plan urban infrastructure. The aim is to spread the message that efficient road design no longer means accommodating as much motorised traffic as possible, but rather maximising people's movement in a safe, comfortable and secure way," says Corey. Training has included government officials from transport and planning ministries as well as local universities in both countries.

Tech-powered teamwork

Our Hong Kong-led team drew on Arup expertise from London, Melbourne, New York, Singapore and Sydney, as well as knowledge gained from our Walking in the Tropics research and insights that emerged during an earlier bus network restructuring project in Hanoi.

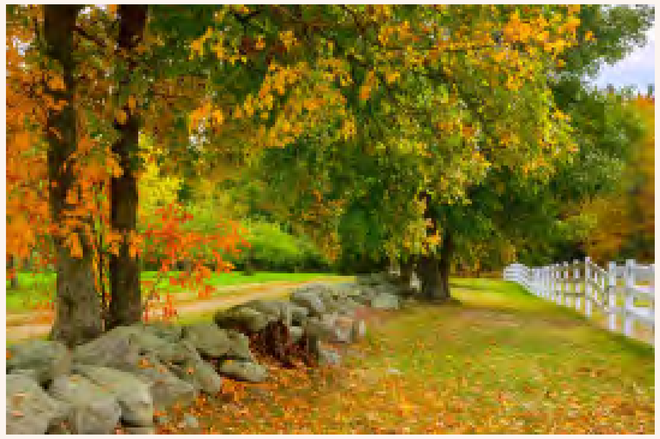
The pandemic meant changing engagement tactics, since our team couldn't survey the local populations' travel habits in person. Instead, we analysed anonymised mobile phone data to understand how people move around the city, building a detailed picture of individual movements and congestion hotspots. We combined these insights with information from other digital tools to map conditions on the ground, identifying key locations for improvements.

A roadmap for preserving cultural treasures

The COVID-19 pandemic provides an opportunity for urban leaders to pause, rethink, and 'build back better' – and authorities in the two cities are working on proposed measures for green, resilient and inclusive transportation. While we wait to see the results in Luang Prabang and Siem Reap, we are exploring ways to take a similar approach across South East Asia and other World Heritage sites globally. Green mobility is just one part of Arup's commitment to sustainability – in this case, it's a powerful way to protect people's health, improve their lived daily lives, and preserve local environments and cultural history.

> "Efficient road design no longer means accommodating as much traffic as possible. It's about maximising people's movement in a safe, comfortable and secure way."

Corey Wong
Associate Director, Transport Consulting



Massachusetts 2050 Decarbonization Roadmap, USA ↗

Analysing how buildings contribute to a US state's greenhouse gas emissions

Decarbonisation of the Great Barrier Reef Islands, Australia ↗

Net-zero futures for communities along the world's most famous coral reef

Belfast Urban Childhoods Masterplan, UK ↗

Building a vision for a healthy, inclusive and child-friendly city

Martha's Vineyard Renewable Microgrid, USA ↗

Renewable energy transition for a public transport bus fleet

Van Brienenoord Bridge, The Netherlands

Embracing a circular approach

View immersive experience ↗

Sabine Delrue
Director, Infrastructure

A game-changing moment takes sustainability to the next level for essential infrastructure.

Next-generation sustainability

Bridges are essential to the highways network in the Netherlands for decades. One of the busiest bridges in the country is the Van Brienenoordbrug, a key connection to the Port of Rotterdam, carrying about 230,000 vehicles daily. It exemplifies the challenge facing the Dutch government and many others globally – so many bridges built decades ago now need renewing. How do we repair and extend the lifespans of such important infrastructure assets? How can it be done safely, sustainably and without excessive disruption? Working closely with our client and partner, we found a way.

Rejuvenating infrastructure, bridge by bridge

We began work on a bridge renovation programme in 2009, collaborating closely with the national highway authority Rijkswaterstaat and our partner RHDHV. Over 12 years we designed the renovation of seven steel bridges, strengthening and upgrading existing structures rather than building new ones. This focus on refurbishment minimised waste, reduced the volumes of new materials needed for construction, and cut the length of time bridges had to be closed to traffic.

Each bridge offered new insights into how to tackle the next, taking us towards the most complex challenge of them all. Part of the Netherlands' busiest highway, the Van Brienenoord bridge comprises 12 lanes of traffic split across the eastbound bridge built in the 1960s and the 1990s western bridge.

Digital expertise, creative thinking

Our work on Van Brienenoord began with a monitoring programme that gathered 70 billion data points from nearly 100 sensors and cameras. This programme informed the calibration of both our structural and geometric models. The structural finite element model was calibrated through strain gauge measurements, while the BIM model used point cloud data to digitally duplicate the actual geometry.

An initial plan for renewing the Van Brienenoord bridge proposed the tried-and-tested option of strengthening with a concrete overlay. But nobody was truly sold on this, including our project manager, Daan Tjepkema. There were concerns about safety and lengthy disruption to traffic, so an alternative using steel plates was suggested. This, too, was rejected because such an innovative technique was untested at this scale.

> “I admire our client for recognising that this solution is the best one. Because they took a risk, too.”
>
> Daan Tjepkema
> Project Manager

An engineering brainwave

“You have to trust your feelings and I knew we hadn’t yet developed the right plan,” explains Daan. Then he had a eureka moment. Why not take out the eastern bridge – the older half – and replace it with the newer, refurbished western bridge. Next, a new bridge structure constructed off site could be installed to replace the western bridge. Daan admits it sounded crazy to swap bridges that are 300m long, but eventually we convinced everyone to go for it.

Embracing circular economy principles, the plan reuses 3,200 tonnes of steel and maintains the bridge in its current form, making it the most sustainable upgrade currently possible.

Preserving an icon

Daan had to work hard to explain the potential of his idea, but within Arup, support came quickly. “This is the reason I love Arup,” he added. “Many engineering firms are focused purely on finishing a contract, but we really want to understand the problem. If anyone has a better solution, people at Arup will love it. And I admire our client for recognising that this solution was the right one, because they took a risk, too.”

It’s also good news for the local community. The Van Brienenoord Bridge is a national icon, seen as a world-leading engineering marvel when it was first built in the 1960s, and its place is now secured for another century.

The future is flexible

Construction begins in 2025 and this renewal will add 100 years of life to both bridge arches. Each side of the bridge will close completely for just six weeks, rather than the alternative plan, which would have required partial closure for 1.5 years. Building on the success of this renovation programme, we have created a Netherlands-based Arup bridge team, whose members work with colleagues globally to share insights, analytical skills, and data-gathering technology.

Project Director Sabine Delrue says bridge design needs to take a more sustainable approach. For long-span structures, the focus should be on maintaining, reusing, and renovating. For smaller and less complex bridges, it’s about flexibility, reusing elements and finding standard parts that can be prefabricated, taken out individually and replaced. “This is the future of bridges,” she says.

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Celebrating arts and culture with an incomparable park and performance space for the people.

A wonder on the water

Manhattan is one of the most densely populated places on Earth, where the potential for new public green space can seem almost inconceivable. It's also a city that is no stranger to ambition so, when the idea of a tree-filled open-air park and performance space built on the Hudson River was first suggested, we knew it had the potential to be a true one of a kind.

Little Island opened in May 2021, the result of years of collaboration with world-renowned architects Heatherwick Studio and MNLA, Hudson River Park Trust and The Diller-von Furstenburg Family Foundation.

A gift to New York

"It's like nothing people have ever seen before. It's amazing to walk through," says Vincent Lee, a New York local and our Global Water Skill Leader. Funded in large part by the foundation – whose $260m donation is said to be the largest to a public park in the city's history – Little Island rises up from the remains of Pier 54 but couldn't be more different from it.

Invisible infrastructure, incredible views

Little Island feels alive even when there are no programmed events. Our theatre venue consultants developed ways to accommodate the infrastructure required to support a range of events, from one-person shows to theatrical performances, large concerts and park-wide art installations, all within a 2.4-acre site. When the infrastructure – including audio and visual equipment – isn't in use, it's largely hidden from sight to preserve the beauty of the space.

Another challenge was storm water. We knew that erecting such a unique structure on the river would demand inventive solutions to manage storm water flows. This is why the whole of Little Island is designed to act like a sponge, returning filtered water gradually back to the river.

Nurturing nature above and below

Heatherwick Studio and landscape architecture firm MNLA designed Little Island to include three performance spaces surrounded by hundreds of species of flowers, trees and shrubs. Our design engineers collaborated closely with architectural partners, constantly sharing advanced 3D modelling and encouraging creativity at every stage.

A critical part of the project was the design of 132 sculpted precast concrete structures that rise up from the river to create the park's undulating surface. In-water construction work paused for months to avoid disturbing annual fish migration and the final design ensures sunlight reaches marine life below. It's a restorative, immersive space where everyone can enjoy fresh air and nature in the heart of the city, whatever the season.

Accessible to all

Little Island is free to visit and open to everyone. Specialists carefully considered wheelchair access for the unorthodox site. Ingeniously hidden utilities help to allow everyone to experience this sanctuary over the water.

The park's programming, education and community relations teams are committed to programming an inclusive range of events, which includes American Sign Language and audio-described offerings. We used our Soundlab technology to ensure performances at Little Island sound as good as possible, simulating soundscapes for pre-construction analysis and making design interventions to minimise noise from Manhattan's traffic.

Setting the stage for the future

At a time when green space and open-air venues in crowded cities have never been more important for public health and wellbeing, Little Island demonstrates what is possible. As Vincent Lee says, when it comes to challenging convention and doing the seemingly impossible in engineering, this is a new high-water mark that future projects will be aiming for.

"It's visually stunning. I used to commute past every day, and it was amazing to see the pots sprouting up."

Vincent Lee
Global Water Skill Leader

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