

The edge of the

**possible**

ARIA Corporate Plan 2024

Advanced  
Research  
+ Invention  
Agency

**ARIA**

“Society faces challenges that are bigger and more complex than ever before. The power of science and technology at our disposal is equally unprecedented. If we harness it with ambition and responsibility, we can rise to meet those challenges and create opportunities for a better life that no one imagined possible.”

**But scientific and technological breakthroughs don't just happen, and they can't be delivered by just anyone. They require a depth and richness of expertise, talent, networks, facilities, institutions, and imagination that exists in only a few special places around the world. The UK is one of them.**

ARIA's job is ambitious but simple: support bold starts that will drive a step change in social and economic prosperity — not just in the UK, but across the world.

How will we do it? By activating the incredible science and technology ecosystem that exists here. By finding those individuals, teams, and communities who dare to think differently about what is possible. And by empowering them to put their ingenuity and determination to work in making their vision of the future real.

In fact, we've already started.

Since joining ARIA in October 2023, our founding Programme Directors (PDs) have defined seven major opportunity spaces — areas where breakthroughs in science and technology can make a huge impact on society but are currently unlikely to occur, either because the ideas are too speculative, too hard, or too interdisciplinary. Exploring those areas through public engagement, expert workshops, and hundreds of meetings and lab visits, they have shaped funding initiatives that are already sparking new ambitions, ideas and research collaborations, all poised to unlock new capabilities across climate, AI, health, manufacturing, and beyond.

ARIA was created to be bold, agile and singularly focused on long-term transformation vs. quick wins. In this first year, we have built a strong foundation to support that mandate: a dedicated team, strong culture, robust operations, and a new approach to catalysing breakthroughs. Next, we'll work to cultivate new communities across our opportunity spaces and infuse them with the entrepreneurial talent, ambition, and partnerships needed to not just imagine the future, but to build it. After all, discovery and inventions cannot change the world unless they form the basis of new communities and networks, products, businesses, supply chains and industries.

Our success is defined by one simple question: when the children of the UK grow up, how will their lives have been transformed by ARIA's work? Whether that's a life-changing technology or a burgeoning new industry, it should be obvious that ARIA played a catalytic role.

We can't guarantee success, nor is there a simple formula we can follow to get there. But one thing is sure: we can't do it alone. It will take our collective ingenuity and determination, a willingness to stumble and keep going, and — perhaps above all — a shared belief that it's possible. So we invite you to join us in taking these first steps together. A collective bold start.



A handwritten signature in black ink, appearing to read 'Ilan Gur', written over a light blue background.

**Ilan Gur**  
CEO

# What if we could?

Many of society's most important advances have stemmed from those with the foresight to pursue new capabilities that most believed to be unattainable.

It will take curiosity and determination, failure and iteration, and the belief that it's possible.



**...solve the mysteries of neurological disorders and mental health by interfacing with the brain in new ways?**

>£100 billion/year – the direct and indirect cost of brain disorders in the UK<sup>1</sup>

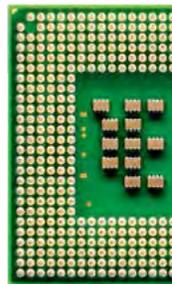


**...programme plants to remove more CO<sub>2</sub>, fight drought, and deliver medicines to those in need?**

1 in 4 children will live in areas with extreme water shortages by 2040<sup>2</sup>

**...use advanced AI to drastically improve our ability to model and control everything from the electricity grid to our immune systems?**

30 minutes – the time it took researchers using AI to identify a bacterial protein structure that had been elusive for 10 years<sup>3</sup>



**...extend Moore's Law to reduce the cost and energy consumption of AI chips by 1000x?**

\$1.8 trillion – size of the global AI market by 2030<sup>4</sup>



**...precisely monitor and predict the effects of climate change across the globe?**

\$9.7 trillion – net present value of halving the uncertainty range for transient climate response by 2030<sup>5</sup>



**...create highly dexterous, general purpose robots to ease the labour shortage of tomorrow?**

100% – growth in the proportion of the UK population aged >65 between 2000 and 2100<sup>6</sup>



**...prevent climate tipping points to avert disaster?**

~200,000 – the number of homes at risk in England by 2050 due to sea level rise<sup>7</sup>

→ Read about our opportunity spaces on pages 17–31

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## Introducing ARIA

# We have one goal: transform the lives of the UK's future generations

The Advanced Research and Invention Agency (ARIA) is a research and development (R&D) funding agency created to unlock technological breakthroughs that benefit everyone. Created by an Act of Parliament and sponsored by the Department for Science, Innovation and Technology, we fund teams of scientists and engineers to pursue research at the edge of what is scientifically and technologically possible.

From climate change to AI and bioengineering, society faces enormous challenges and opportunities that can be uniquely addressed by science and technology. ARIA was created to activate the UK's world-class R&D talent in new ways, so that we can meet these challenges and opportunities head on.

Our success is shaped by one question: how will ARIA transform the lives of the UK's future generations? Whether that's a life-changing new technology or a burgeoning new industry, it should be obvious that ARIA played a catalytic role.

## Our approach

**Activating** scientists + engineers in new ways and **directing** breakthrough R&D in underexplored areas to **catalyse** new paths to prosperity for the UK and the world.

### **Empowering scientists and engineers to push the limits of what's possible**

Fundamentally, we believe people drive innovation. Their creativity and ingenuity are the biggest assets we have. That's why our core model focuses on empowering scientists and engineers with the resources and flexibility to pursue world-changing breakthroughs.

That starts with our Programme Directors (PDs): scientists and engineers tasked with developing a concrete vision for how technology could enable a better future and who then direct funding into research that can make it a reality. ARIA PDs retain creative control of the direction of their projects and programmes, and have flexibility over how, who and what R&D they fund.

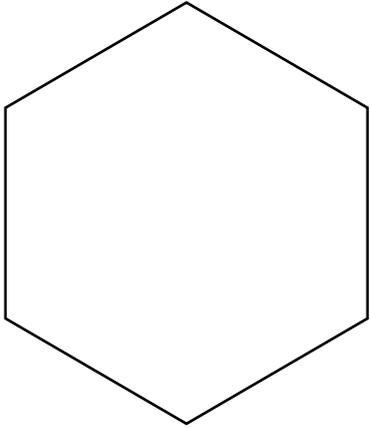
Our commitment to backing people with clear visions and bold ideas extends to our R&D Creators, individuals and teams that ARIA will fund and support. Our PDs play a central role in selecting Creators – they look for the best ideas and expertise, wherever they may come from – help shape their objectives, and hold them accountable in delivery.

**“In any organisation like ARIA, there will always be the temptation to look for quick wins or safe bets in an effort to start to show results. If we're staying true to our mission, only a fraction of our programmes will succeed, but the impact of those that do will be world changing.”**

**Matt Clifford**  
Chair

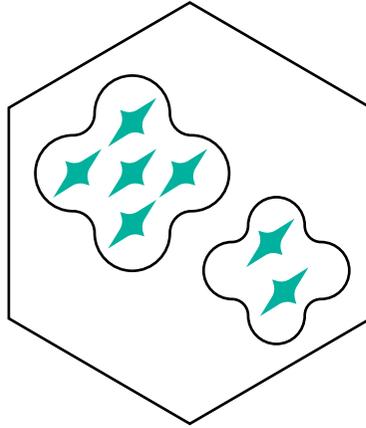
# Our approach continued

## Our PDs are tasked with:



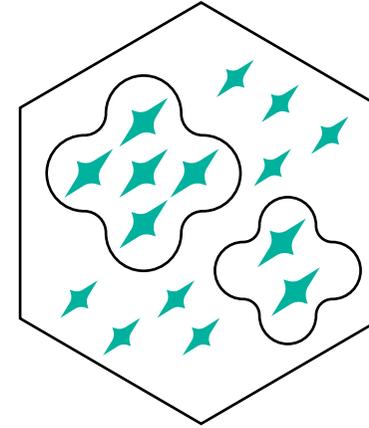
1

**Defining an opportunity space:** an area we believe is likely to yield breakthroughs. An ARIA opportunity space must be highly consequential for society; under-explored relative to its potential impact; and ripe for new talent, perspectives, or resources to change what's possible.



2

**Formulating and pursuing one or more ambitious R&D programmes:** from that space, PDs will build a multi-year R&D programme, directing funding across research disciplines and institutions toward a focused objective. Within a programme, PDs select and fund a portfolio of R&D projects, whose aim is to unlock new technical and scientific capabilities and advance the programme's success and impact on society.



3

**Awarding seed funding:** beyond programme funding, PDs can support individuals or teams pursuing research aligned to their opportunity space that otherwise might fall through the cracks. With smaller budgets, less structure and shorter timeframes, opportunity seeds support researchers to uncover new pathways that could inspire future programmes or justify additional support as a standalone project.

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Our integrated activity will lead not only to technical breakthroughs, but also to new communities of practice, institutional capacity, and capital inflows – all of which are essential for large-scale transformation.

# Our approach continued

## Reaching across disciplines, sectors + institutions to activate the UK's world-class R&D community

While PDs are tasked with defining a clear technical objective and designing a path to pursue it, they won't get there alone. To build a strong and well-informed thesis, our PDs proactively engage across the R&D ecosystem – from the earliest stages of programme development through to finding and funding researchers who can turn their emerging visions into reality.

Since joining ARIA in October 2023, PDs have sought insights from experts across the R&D ecosystem. Through workshops, public calls for feedback, and open solicitations, we've invited input to help us consider different directions, surface new ideas, and start building multidisciplinary communities around opportunity spaces.

Breakthroughs often rely on a mix of academic and industrial capabilities that can be hard to find in a single organisation. To plant the seeds for entirely new industries and capabilities within the UK, we'll need to break down silos and reach across institutional boundaries. That means funding across the ecosystem, in startups, small and large companies, philanthropic organisations, research institutions and universities.

To help us build cross-disciplinary trust, engagement, and connectivity, we are building a network of formal and informal partnerships with complementary organisations within the UK and abroad. Whether it be tapping into the Royal Academy of Engineering's technical expertise; leveraging the breadth and diversity of UKRI's knowledge base, sourcing humanities and social science insights through the British Academy; or incorporating venture creation learnings through our upcoming science entrepreneurship partnerships – we'll only get to world-changing impact by working together with like-minded organisations who share our vision and can help propel it forward.

**“The Royal Academy of Engineering is excited to be partnering with ARIA to open up access to the wider community of engineering and tech talent. By aligning our networks we can create greater momentum behind ARIA's mission and cluster in more creative, specialist expertise around the opportunity spaces identified by PDs.”**

Hayaatun Sillem  
CEO, Royal Academy of Engineering

## Q SPOTLIGHT

### Building ARIA – early discovery

We have an ambitious mission. From the start, we knew we'd need input from the science and technology ecosystem to build a new kind of R&D funding agency from the ground up.

We kicked off the autumn of 2022 with a series of roundtables, convening scientists, engineers, entrepreneurs, and investors from a range of disciplines, backgrounds, regions and industries. Through an open call for self-assembled groups, we brought together people who could help us understand how we could design ARIA to maximise our impact.

The conversations were critical in surfacing ideas to unlock talent in the UK and beyond, amplify and activate the existing strengths in the system, and connect with networks that might yield our first cohort of Programme Directors.

# 50+

roundtable discussions

# 100

CEO bilaterals

# Our approach continued

## Q SPOTLIGHT

### What makes an ARIA Programme Director?

Doing things differently requires people who see things differently. Before we could find the people capable of leading world-changing programmes, we needed to know what we were looking for.

With no direct precedent in the UK to draw from, we interviewed key players across the global R&D ecosystem – including 60 experts who worked at/with the Defense Advanced Research Projects Agency (DARPA) and its related agencies – to understand what makes PDs successful.

We used the findings to inform a unique set of selection criteria, and launched a global recruitment call – the most open of its kind – to assemble our first cohort. Alongside deep technical and scientific expertise, we looked beyond typical markers and focused on identifying a unique mix of qualities: creative independence of thought; adaptability; a willingness to experiment, fail, pivot and persevere in pursuit of something important; and an ability to lead with conviction.

The search culminated with 16 finalists assembling in the British Library, joined by scientists and innovators from the ARIA Board and our advisory network.

The result: eight individuals who are now pioneering ARIA's work, spanning fields such as applied electrochemistry, plant physiology, artificial intelligence, and neuroscience.

# 400

applications

# 80

hours of application review

# 66

hours of video interviews

“An ARIA Programme Director isn’t defined by a specific academic credential, nor a particular professional background. It’s the boldness to imagine a different future, and the ability to take us there. As we look to our next cohort of Programme Directors, we are continuing to search for those who will push us past what’s possible – whoever and wherever they may be.”

Pippy James  
Chief Product Officer



Our first group of Programme Directors. Read more about them and their visions for the future on pages 17–31.

# Our approach continued

## Q SPOTLIGHT

### Inside an ARIA workshop

Our ability to generate scientific breakthroughs will hinge on the strength of communities we build around our opportunity spaces. An ARIA workshop is the first formal opportunity PDs have to start to bring those communities together – inviting a diverse group of experts to share feedback on their emerging programmes, and strengthen their thinking.

In stepping into a workshop, we want participants to feel they are entering a new space – one where there are no limits for what science and technology can achieve. Through structured sessions and free-flowing conversations, participants are encouraged to challenge PDs on programme direction, share their perspectives on what might be possible, and what we'd need to unlock to get there. Following one or two days of debate and discussion, PDs collate and directly integrate feedback into their proposed methodologies, approaches and even programme objectives.

### Example questions posed to ARIA workshop participants:

What climate science breakthroughs are vital to fundamentally change our thinking?

What would the specifications of a product launched in 2050 look like?

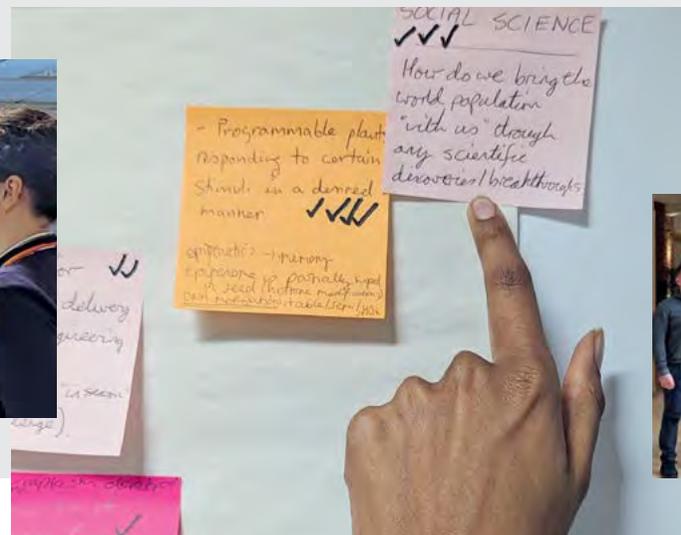
What will robotic manipulation look like in 100 years time (and how will we get there)?

“ARIA workshops are designed to reach across the R&D ecosystem to spark new conversations and connections within opportunity spaces, often between people who might not otherwise meet. This input from the community is crucial to shape a programme’s goals.”

Muji Ahmedi  
Product Operations Associate

“Your programme workshop brought a diverse representation of the community together to debate both challenges and opportunities. I think you’ve done a great job in invigorating the UK community in shared ambitions and the desire to collaborate in these.”

Russell Harris  
Professor, University of Leeds



# Our approach continued

## Delivering breakthrough R&D through science entrepreneurship

To ensure we create the transformative outlier outcomes ARIA was set up to achieve, we'll need entrepreneurship to advance science like it has technology.

From the focused, iterative, entrepreneurial approach our PDs take to define their research programmes, to harnessing the drive of startups to commercialise impact from any technical breakthroughs emerging from our programmes, ARIA is baking science entrepreneurship into all that we do.

While early-stage innovation can't be perfectly engineered, our mandate requires us to do all we can to ensure successful outcomes from our funded R&D.

Beyond programme design, we'll do this by **maximising viable paths to deployment and minimising barriers to scale**. Our approach to funding is based on a commitment to that principle, and aims to ensure the projects and programmes we fund have the greatest chance of bringing transformative benefits to the UK. Our funding terms are science-founder friendly, and aligned with the entrepreneurial forces that will ensure successful programmes deliver the greatest outcomes for society.

We know discovery alone won't change the world. We'll need to **support ambitious, risk-taking entrepreneurs, startups and capital sources to convert our R&D into widespread impact**. To that end, we are exploring new mechanisms for actively driving entrepreneurial talent and venture creation within our opportunity spaces. Central to our activity will be finding key partners dedicated to entrepreneurial community building and venture creation activity, who can help unlock latent ideas, introduce and empower new talent, support promising early-stage ventures, and provide commercial insights and connectivity to the researchers we fund.

## PROGRAMME SPOTLIGHT

### What is an ARIA programme?

Our multi-year R&D programmes are designed to advance complex, large-scale ideas which require coordinated investment and management across disciplines and institutions. To build a programme, each PD directs the review, selection, and funding of a portfolio of projects, whose collective aim is to unlock breakthroughs that line up to the programme's objectives.

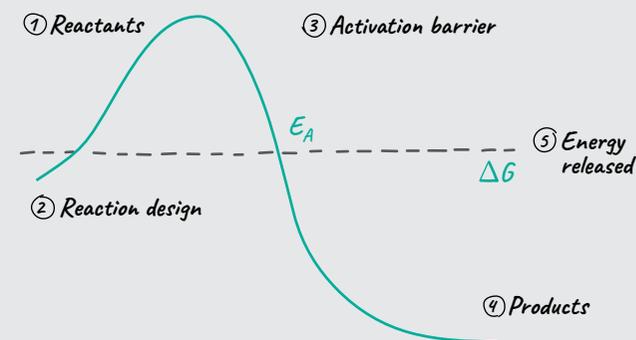
### How does it get approved?

All opportunity spaces documents and programme theses go through an open consultation process. Once feedback is integrated, all proposed programmes have to be approved by ARIA's leadership team, with input from arms-length expert reviewers based on a set of clear evaluation criteria. Our Board are responsible for ensuring robust processes are in place and followed in review and selection of programmes and projects.

### How do we select projects?

Following open funding calls, PDs make final project selection recommendations to optimise the programme portfolio as a whole and its alignment with the programme's objectives. Expert reviewers (both internal and external to ARIA) evaluate proposals to provide independent views, stimulate discussion and inform decision-making. All reviewers are signed off by ARIA leadership as qualified and conflict-free.

## We think of an ARIA programme as a chemical reaction, composed of five key elements



1. **Reactants:** what knowledge, talent, or institutional capacity do we need to fuel this programme?
2. **Reaction design:** how will we fund and coordinate the reactants? What are the critical steps, intermediates, and timescales?
3. **Activation barrier:** why is this unlikely to happen or succeed without our intervention?
4. **Products:** if successful, what will the programme produce?
5. **Energy released:** what value will we create for society and why do we believe there will be a strong driving force for that impact beyond the end of the programme?

# ARIA's Model of Impact

## Catalysing a better future for the UK + the world



# Building for breakthroughs

Our first three years

## Ensuring focus, delivery + accountability

ARIA sets stretching annual goals collaboratively with the whole team.

These inform quarterly objectives that are tracked to ensure focus, delivery and accountability.

# 1

**2023/24**

Accomplished

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### Set the foundations

- Recruit exceptional and diverse technical and operational leaders
- Empower our teams to operate with agility and excellence
- Establish a strong, inclusive culture aligned with our values
- Build stakeholder trust and excitement in ARIA's early team/work

# 2

**2024/25**

Planned

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### Launch the core elements

- Launch first programmes across our opportunity spaces
- Integrate science entrepreneurship across everything we do
- Build a strong R&D Creator community and broaden awareness of ARIA

# 3

**2025/26**

Anticipated direction

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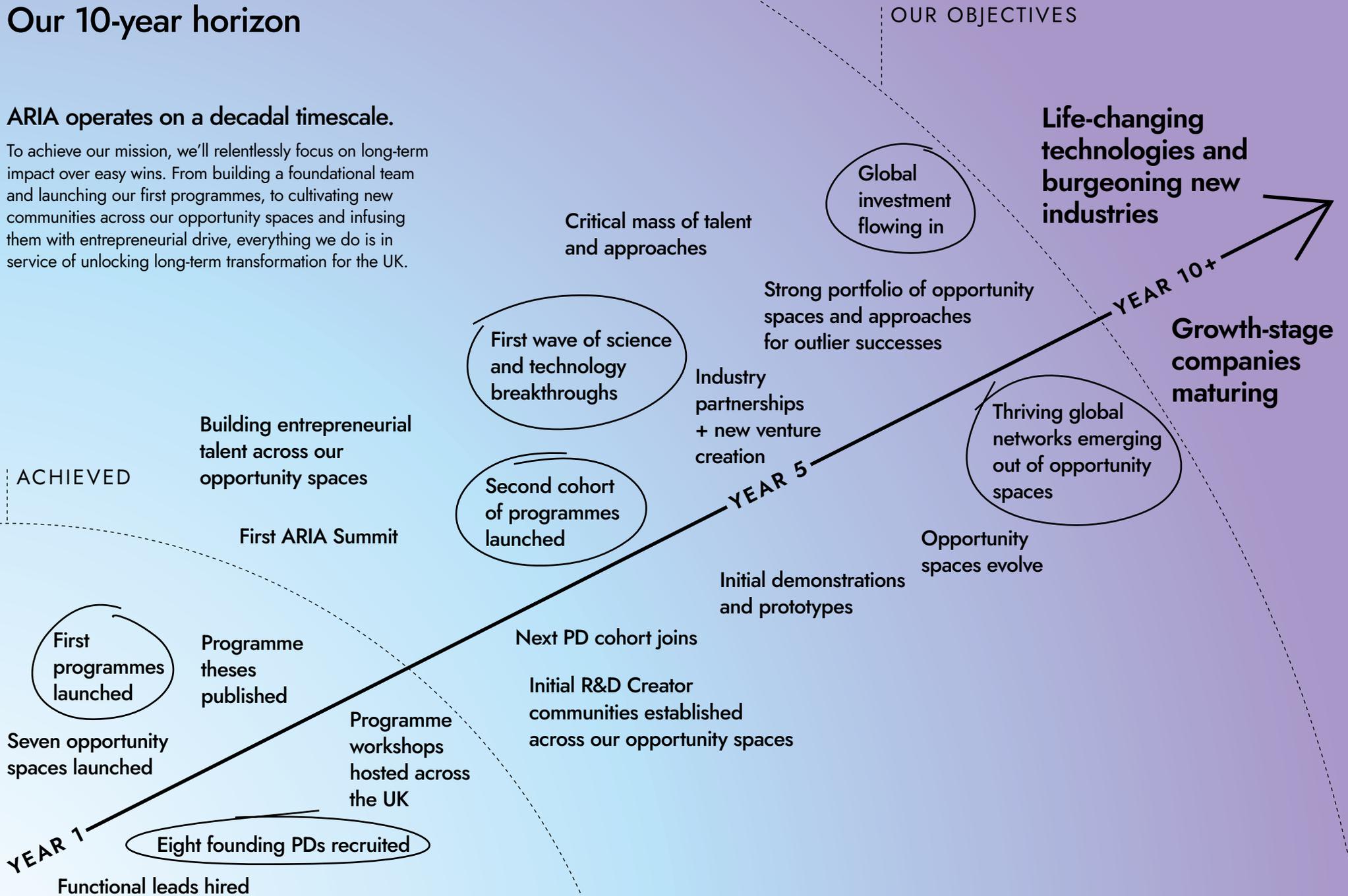
### Build critical mass

- Onboard second cohort of Programme Directors to launch programmes in existing and new opportunity spaces
- Shut down or pivot dead-end efforts, and double down on those that show promise
- Expand partnerships within and across opportunity spaces

# Our 10-year horizon

## ARIA operates on a decadal timescale.

To achieve our mission, we'll relentlessly focus on long-term impact over easy wins. From building a foundational team and launching our first programmes, to cultivating new communities across our opportunity spaces and infusing them with entrepreneurial drive, everything we do is in service of unlocking long-term transformation for the UK.



## Boldness with accountability

# Pursuing potentially world-changing technologies requires a highly responsible approach

### Organisational governance

ARIA was designed to act as an independent organisation with the freedom to pursue bold and speculative breakthroughs. That independence is only made possible through a high degree of accountability. The Board of Directors plays a critical role in scrutinising our strategy and ensuring responsible governance. As a public body sponsored by DSIT, we are also accountable to Parliament and its select committees, and audited by the National Audit Office.

**“To succeed, ARIA must move forward at speed, balancing operational excellence and strong governance with a bold, breakthrough-enabling culture. Drawing on our collective experience from across scientific research, industry and government, it’s our responsibility to help ARIA get that balance right.”**

**Dame Angela McLean**  
UK Government Chief Scientific Adviser  
and ARIA Board member

### Responsible research

Our opportunity spaces and emerging programmes embody our mandate — to pursue new technological options that are currently intractable but have transformative potential for humanity.

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#### Building in public

We openly publish and solicit feedback on opportunity spaces and programme theses before launching a solicitation, and publicise all awarded research projects.

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#### Criteria-based expert review

We evaluate all proposals against consistent criteria, with expert reviewers external to ARIA providing independent views that inform decision-making. All funding decisions are subject to such review, with leadership oversight over both consistency in process and selection justifications.

But research at the edge of the possible requires a highly responsible approach. To that end, the following accountability principles are built into all of our research activities:

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#### Broad engagement

We have engaged across academia, industry, charities, funders, entrepreneurs and government, to inform both our core operating model and our emerging programmes. As our activities progress, we will continue to seek input from and leverage the strengths of stakeholders across and beyond the R&D system — including not just technologists, but social scientists and civil society groups.

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#### Integrity with oversight

We expect all staff and funded researchers to abide by the Concordat to Support Research Integrity principles, and to work with due respect for one another within a supportive, inclusive environment. Our Board subcommittee on ethics and social responsibility provides added oversight to ensure these principles are followed in development and management of all our programmes.

# Boldness with accountability continued

## Our team – strength in diversity

Our team is built to think differently. We've joined ARIA from start-ups, non-profits, VCs, and the public sector, from across the UK and beyond, so we bring different perspectives and celebrate new ideas. We're strongly bound by a shared belief in the power of science to improve society.

Embracing a diversity of ideas and backgrounds is crucial for ARIA's success. The diverse perspectives on our team allow us to think differently, which fuels our mandate to reimagine what's possible. Meanwhile, if ARIA's work is to succeed in serving UK society, we want our team to reflect as closely as possible the communities that we aim to serve and will continue to prioritise this as we grow — reviewing our recruitment processes to ensure they are inclusive every stage, and growing our networks to reach a diverse pool of potential candidates across all of our roles.

**56%**

female employees  
(including 50:50  
PD cohort)

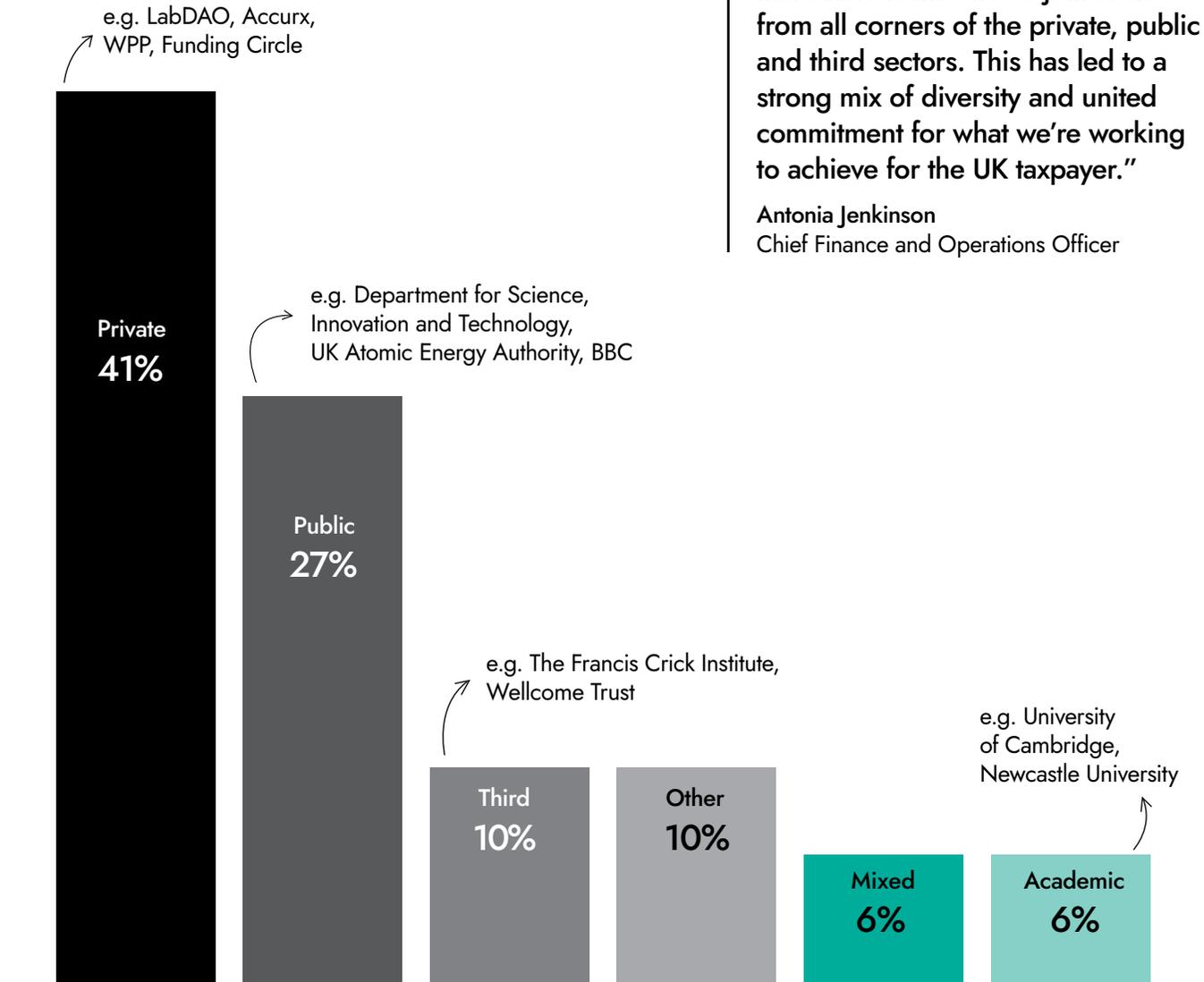
**24**

different  
ethnicities

**13%**

neurodiverse

## Our team's primary career background prior to joining ARIA:



"We are excited to have built an incredible team who've joined us from all corners of the private, public and third sectors. This has led to a strong mix of diversity and united commitment for what we're working to achieve for the UK taxpayer."

Antonia Jenkinson  
Chief Finance and Operations Officer

# Empowering scientists to reach for the edge of the possible

Every Programme Director joins ARIA with a vision for what the future could look like. This starts with an opportunity space, an area that we believe is likely to yield breakthroughs.

Each opportunity space represents fertile ground we'll harvest for technical breakthroughs. Over time, each will serve as a bedrock for various multi-year programmes directed by the PDs, as well as additional flares of seed funding to support researchers pursuing bold ideas.

Our opportunity spaces are designed as an open invitation for researchers from across disciplines and institutions to learn with us and contribute – a variety of perspectives are just what we need to change what's possible.



# Scalable Neural Interfaces

Jacques Carolan  
Programme Director

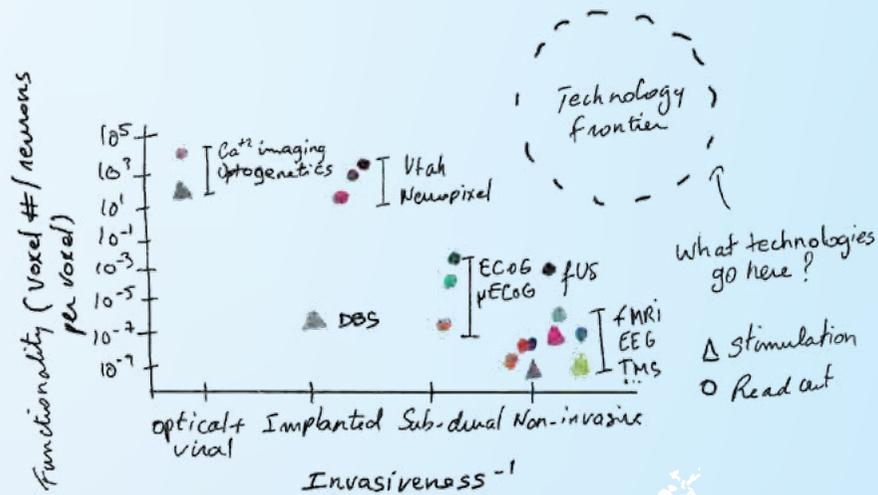
**Neurological and neuropsychiatric disorders are the cause of an overwhelming societal and economic burden.**

In the UK alone, the direct and indirect cost of brain disorders is >£100 billion/year, and treatment options are not yet incorporating the latest in technological advances to rethink how we interface with the human nervous system. Current paradigms and procedures designed to ease suffering typically trade off precision for invasiveness. But by connecting the frontiers of engineered hardware with the frontiers of engineered biology we can eliminate the need to choose between the two. In this opportunity space, we are exploring how to advance highly targeted minimally-invasive neurotechnologies to understand and repair the brain.

**“To get to this opportunity space, I really expanded my network – I reached out to the authors of papers I thought were awesome and got them to recommend others, spoke to people at the top neurotech companies in the world, and also with those working at agencies like DARPA and IARPA. What I’m working on requires coalescing a community around a particular goal to be effective – and that’s super unique in what ARIA is capable of doing.”**

Jacques Carolan  
Programme Director

# Scalable Neural Interfaces continued



“ARIA has recognised that rapidly advancing neurotechnology combined with a deeper understanding of the circuit nature of many neurological disorders could yield far more effective therapies for brain disorders that are not effectively managed with drugs alone. Mental health and neurological disorders are some of the most costly and devastating disorders worldwide. By approaching brain disorders at the source, the circuits involved in these diseases, it should be possible to create devices that treat brain disorders as effectively as pacemakers to treat cardiac disorders today.”

Jacob Robinson  
 Founder and CEO of Motif Neurotech and Professor, Rice University

Jacques has engaged with researchers and industry leaders like Jacob through workshops, one-to-one meetings, public talks, and university visits.

## Discovery

So far, Jacques has visited numerous labs and institutions across the UK, including:

University College London, Imperial College London, the Francis Crick Institute, Borna Research Institute, and Harwell Science and Innovation Campus



Jacques Carolan is an applied physicist and neuroscientist. He spent a decade building quantum computing technologies before pivoting into systems neuroscience where he developed optical technologies to understand living brains. Prior to ARIA, Jacques was a BBSRC Discovery Fellow at the University College London.

🔗 To see this full opportunity space PDF, including original diagrams, go to: [aria.org.uk/what-were-working-on](https://aria.org.uk/what-were-working-on)

# Programmable Plants

Angie Burnett  
Programme Director

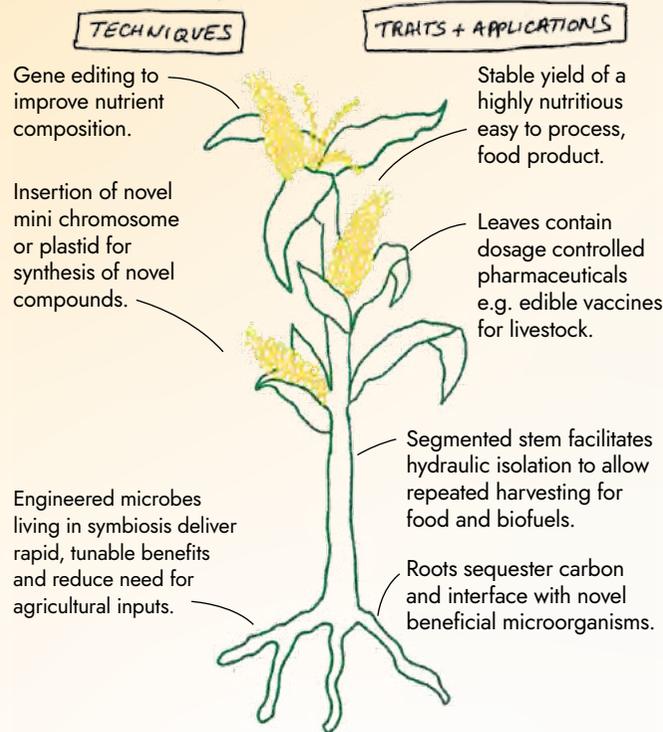
Today's agricultural system is struggling with the dual challenge of sustainable food supply and stable climate.

Growing uncertainty and severity of extreme weather events is set to compound the problem. Comprising 80% of the world's biomass, plants represent a hugely sustainable, low-cost technological platform. Through Programmable Plants, we are harnessing advances in gene editing technologies and synthetic biology to transform our ability to address food insecurity and environmental degradation by allowing us to predictably and efficiently build new plants.

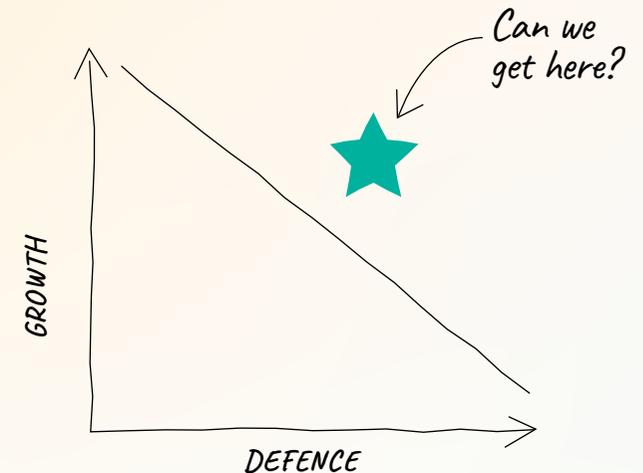
**"Plants are the foundation of human life on Earth and are critical for securing our future. Recent advances in genetic technologies and synthetic biology can be unified to push the limits of what's possible in plant science, to develop resilient crops and ecosystems for tomorrow's world."**

Angie Burnett  
Programme Director

## Possibilities for a programmable plant



AI can guide edits and select transformed plants but we need innovations in method development to streamline design.

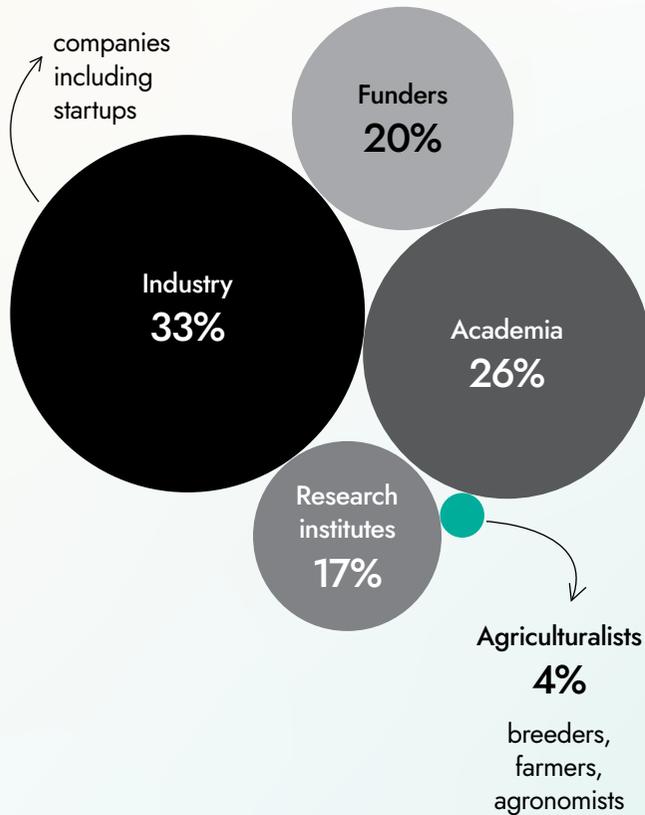


*In the future we'll design, write and build fully synthetic crop genomes.*

# Programmable Plants continued

## Discovery

To define her opportunity space, Angie has been engaging with experts across sectors and disciplines:



**“ARIA’s focus on fast cycling, on equity in terms of target species, and on design control over plants is exactly what this planet needs to turn agriculture from a tax on our planet to one that is in harmony with it.”**

**Brad Zamft**

Project Lead, X, the moonshot factory

*Angie has engaged with researchers and industry leaders like Brad through workshops, one-to-one meetings, public talks, and university visits.*



Angie Burnett is a plant biologist and has spent the last decade focusing on understanding the power of plants to solve some of our most pressing challenges such as food insecurity, climate change and environmental degradation. Previously, Angie was a Research Associate at the University of Cambridge.

🔗 To see this full opportunity space PDF, including original diagrams, go to: [aria.org.uk/what-were-working-on](https://aria.org.uk/what-were-working-on)



# Mathematics for Safe AI

David 'davidad' Dalrymple  
Programme Director

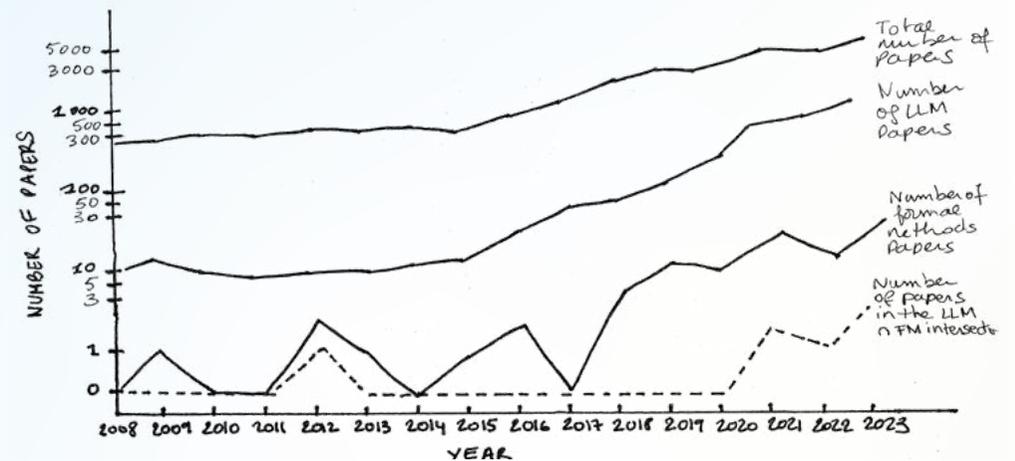
As AI becomes more capable, it has the potential to power scientific breakthroughs, enhance global prosperity, and safeguard us from disasters – but only if it's deployed wisely.

Davidad believes a combination of scientific world-models and mathematical proofs could be the answer to ensuring AI provides transformational benefits without harm. In this opportunity space, we are exploring how to leverage mathematics and scientific modelling to advance transformative AI and provide a basis for provable safety.

"I started taking AI safety seriously as a hugely important area in around 2017, identifying formal methods as a neglected angle. I'm most excited about demonstrating that we can leverage frontier AI for economic and societal benefits while also obtaining quantitative safety guarantees, like we've come to expect from critical infrastructure in other sectors."

David 'davidad' Dalrymple  
Programme Director

Comparison of (ICML, ICLR, NeurIPS) papers on LLMs vs Formal Methods



# Mathematics for Safe AI continued

## Programme thesis – Safeguarded AI: Constructing guaranteed safety

This thesis sets out the goal of prototyping and demonstrating a toolkit for building safety measures designed to channel any frontier AI's potential responsibly. Envisioning a pathway to leverage frontier AI itself, the aim is to construct a "gatekeeper" – a targeted AI whose job it is to understand and reduce the safety risks of other AI agents.

### What will success look like?

A successful programme will demonstrate proof-of-concept, with the potential to transform how the scientific community thinks about what is possible in this space.

Proving that "AI with quantitative safety guarantees" is a viable pathway holds the potential to yield meaningful economic dividends. Full deployment of AI decision-support tools or autonomous control systems compared to today's systems is estimated to accrue billions of pounds – and, critically, reduce our vulnerability to potential future "rogue AIs".

## Discovery

"I was surprised to learn from one of the leading academics in static verification of neural networks, Tom Henzinger, that he believes runtime verification is critical to scalability going forward. This has implications for the entire programme: all verification-critical processes must be able to run fast, and online."

David 'davidad' Dalrymple  
Programme Director

**"AI is likely the most important technology of our time. However, we do not yet understand how to make the prevailing large neural network architectures safe, and may not be able to ever. This could have very dangerous consequences.**

**This research agenda offers an antidote; a compelling, original and exciting alternative path to building powerful safe-by-design AI systems that we can trust. If successful, this would allow us to get the wonderful upsides from powerful intelligent technology – transforming our society in profoundly good ways – without taking large risks."**

Marc Warner  
CEO, Faculty

*davidad has engaged with researchers and industry leaders like Mark through workshops, one-to-one meetings, public talks, and university visits.*



David 'davidad' Dalrymple is a software engineer with a multidisciplinary scientific background. He's spent five years formulating a vision for how mathematical approaches could guarantee reliable and trustworthy AI. Before joining ARIA, davidad co-invented the top-40 cryptocurrency Filecoin and worked as a Senior Software Engineer at Twitter.

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# Nature Computes Better

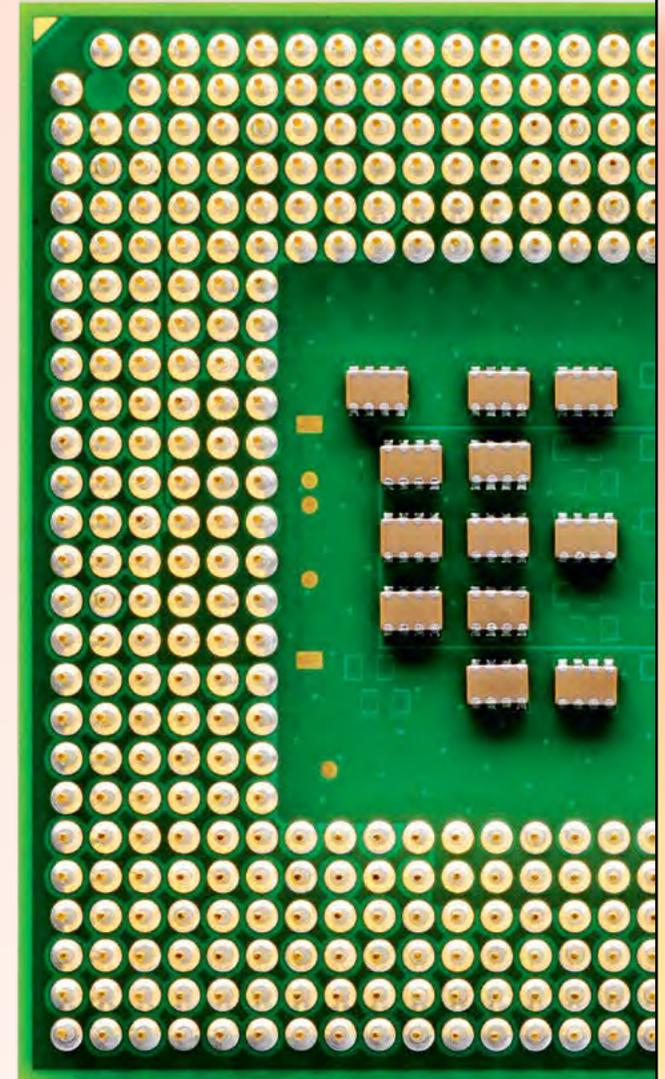
Suraj Bramhavar  
Programme Director

**From improving our understanding of how proteins fold, to building self-driving cars, we know transformative new capabilities arise with more computing power.**

But the recent growth of AI exacerbates an already unsustainable demand for compute, with increasing performance requiring increasing costs for the first time in history. In *Nature Computes Better*, we are examining whether the natural world presents us with an opportunity to redefine the way computers process information. By exploiting principles ubiquitously found in the natural systems – typically orders of magnitude more efficient than silicon microprocessors – we will seek to build dramatically more efficient computers.

“The remarkable thing about AI is that all these incredible things we’ve seen it do all use a very narrow set of algorithms and an even narrower set of hardware blocks. It stands to reason that this is not the only way to do things.”

Suraj Bramhavar  
Programme Director



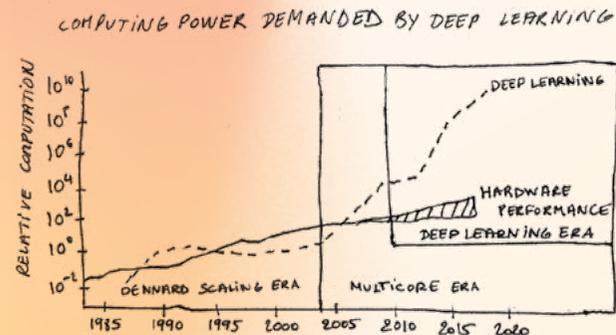
# Nature Computes Better continued

## Programme thesis – Unlocking AI compute hardware at 1/1000th the cost

By calling into question key tenets underpinning our digital computing infrastructure, we are aiming to create a toolkit for computer architects to realise AI compute hardware at a fraction of its current cost.

### What will success look like?

A successful programme will unlock a new technological lever for next-generation AI hardware, alleviating dependence on leading-edge chip manufacturing and opening up new avenues to scale the AI processing industry – which is expected to be worth trillions of pounds. Capabilities proven out in the AI domain will cascade into numerous disciplines beyond AI where information processing is critical, from scientific simulation to communication systems.



## Discovery

To hone in on a programme out of this opportunity space, Suraj spoke to more than 100 of the leaders working in advanced computing, ranging from academics working on exploratory theories, to industry experts, startup founders, private investors, and public-body funders.

“As we’ve pushed the frontiers of computing over the past half century, a surprising amount has remained constant — processing and memory are kept separate, and digital operations power all mainstream computing. We now face an unprecedented scale of computing demand, and one of most promising paths to find how we meet this demand is analog compute.

Breaking out of the hegemony of digital requires not just courage but a huge amount of full stack thinking, with innovations across materials, circuits, architecture and algorithms. This ARIA programme has the potential to unlock an advantage for the UK which I believe will have outsized returns for decades to come.”

Walter Goodwin  
CEO and co-Founder, Fractile AI



Suraj Bramhavar is an electrical engineer. His work focuses on how we can redefine the way computers process information to build dramatically more efficient computers. Suraj joined ARIA from Sync Computing, where he was co-founder and CTO, which optimises the use of modern cloud computing resources. The company was spun-out from his research at MIT Lincoln Laboratory. Suraj previously worked at Intel Corp, helping transition silicon photonics technology from an R&D effort into a business now worth over \$1BN.

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# Scoping Our Planet

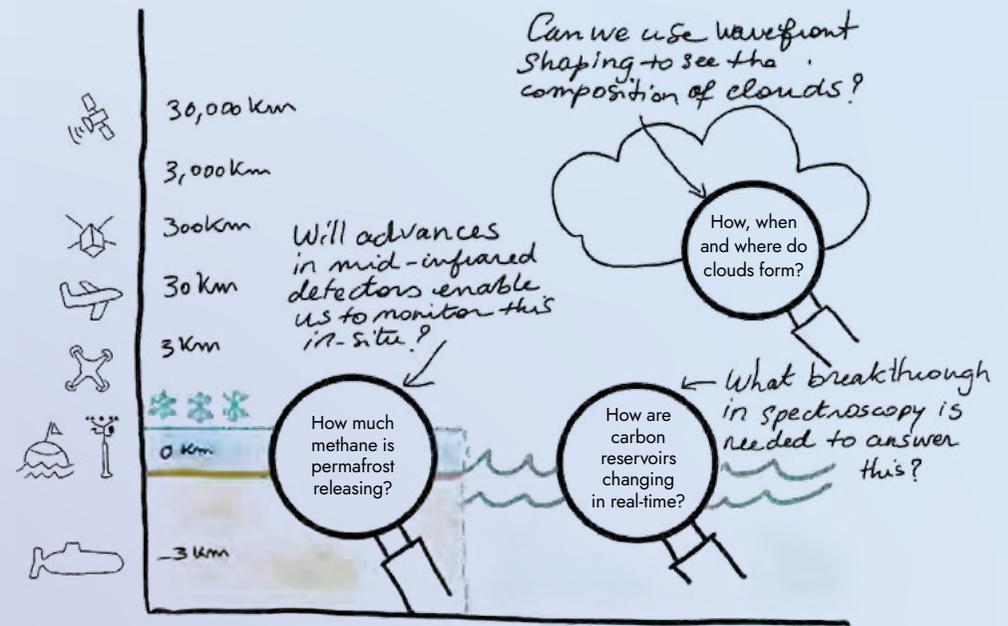
Gemma Bale + Sarah Bohndiek  
Programme Directors

Current climate measurements fail to provide the coverage, resolution or sensitivity necessary to adequately and effectively respond to the climate crisis.

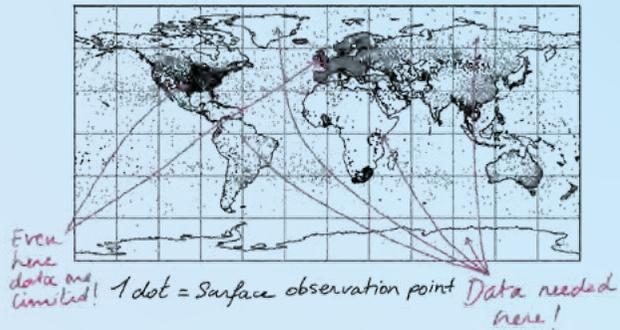
Serious gaps in our measurement systems are leading to uncertainties in weather forecasting and climate predictions, which are critical for effective climate management. Scoping Our Planet will explore whether new applications of optical technologies can help fill these gaps. By harnessing advances in optics and photonics, including unprecedented new control of light and its interactions with the environment, we seek to transform the accuracy of weather forecasts and climate projections, and provide early warning signs of extreme weather events and tipping points.

“There are some really big gaps in how we’re monitoring the climate, from physical coverage, to how we measure parameters. This is really consequential for our ability to respond effectively to the climate crisis – you can’t manage what you can’t measure.”

Gemma Bale  
Programme Director



# Scoping Our Planet continued



## Discovery

"We came into ARIA thinking about the decentralisation of healthcare and how new technologies could help better manage individual health. But as we came to understand ARIA more, and the time scales over which we're trying to create impact, we increasingly thought that what was under-explored in optics was not the health of people on the planet – but the health of the planet itself."

**Sarah Bohndiek**  
Programme Director

"Clouds and aerosols have a profound effect on climate but these effects are not well captured by models, giving rise to large uncertainty in the planetary and regional responses to change to date. In part this is due to a lack of observations with sufficient detail and coverage to constrain process descriptions in models. Such observations are challenging and require substantial investments in time and infrastructure to develop new instruments capable of delivering the information that is needed.

ARIA's approach to support new optical approaches to observing clouds and aerosols will be transformational and will offer a platform for future observationally driven climate science for the coming decades."

**Hugh Coe**  
Professor of Atmospheric Composition,  
University of Manchester

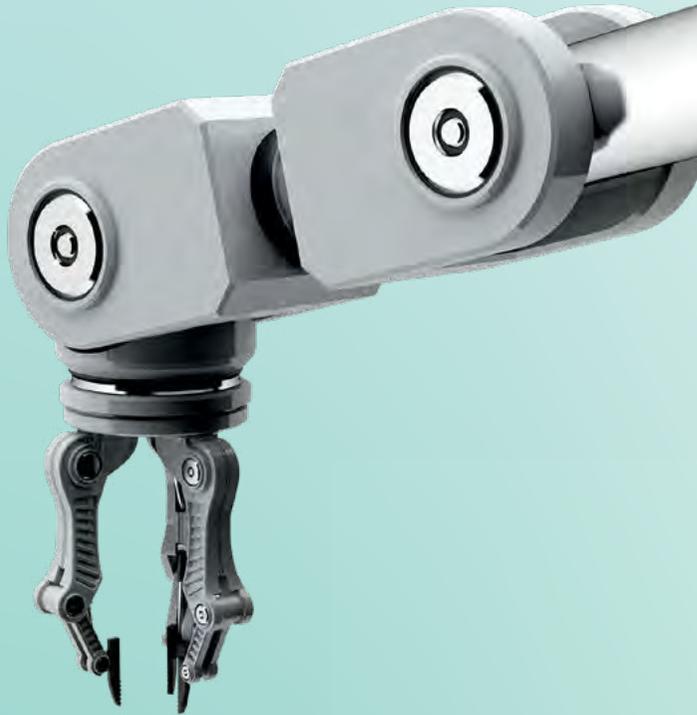
*Sarah and Gemma have engaged with researchers and industry leaders like Hugh through workshops, one-to-one meetings, public talks, and university visits.*



Gemma Bale and Sarah Bohndiek are biomedical physicists working as co-Programme Directors. They both joined ARIA from the University of Cambridge, where Gemma continues to lead teams working on non-invasive brain monitoring, and Sarah in optical imaging technology for earlier cancer detection.

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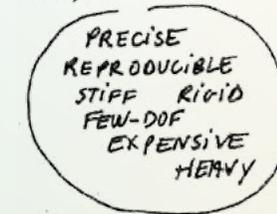
# Smarter Robot Bodies

Jenny Read  
Programme Director

Between 2000 and 2100, the proportion of the world population aged 65 and older will triple, bringing with it increasing labour shortages, especially for physically demanding work.

Despite recent advances in computing, our ability to use robots to ease the burden will be hampered by the limited capabilities of robotic bodies. Through this opportunity space we seek to understand how progress in AI, control, materials, and manufacturing could help improve robotic bodies, unlock the benefits of intelligent machines and improve human productivity and welfare.

Previously accessible design space



Opportunity space opened up by recent advances

# Smarter Robot Bodies continued

## Programme thesis – Robotic Dexterity: Handling our future

Millions of people around the world perform taxing and dangerous labour, often in hazardous environments like sewers, factories, or chemical plants. Despite steady progress in robotics hardware, and with AI enabling robots to venture into more complex and challenging environments, general dexterous manipulation remains an unsolved problem. Our machines are currently unable to handle heavy, deformable, delicate and damp objects with minimal damage or error rates, and therefore cannot perform the complex physical tasks currently done by humans.

This thesis asks if a paradigm shift in robotics hardware could help shoulder this burden.

### What will success look like?

Success for this programme would be a paradigm-shift in robotic abilities, relieving the human workforce of dangerous, taxing and repetitive tasks already being done today, while also establishing the basis for a powerful new industry helping to address the labour challenges of tomorrow.

## Discovery

While developing this opportunity space, Jenny has toured robotics and AI labs across England, Scotland and the US. To understand existing bottlenecks and opportunities for improvements, Jenny's been speaking to teams across academia, industry and the public sector, ranging from the people building and designing robots to those projecting the labour demands of the future.

**“ARIA’s robot dexterity opportunity space helped me stop and think how useful it would be if we could show our robots how to do something, and trust them to help – but the fabulous range of movement that humans are capable of is very hard to recreate in a machine. ARIA’s commitment to improving robot dexterity through hardware will give a much-needed boost to UK talent in this socially and economically-critical domain, and its flexible and person-led approach feels meaningfully inclusive to us as a research-intensive micro-SME. I’m hopeful that many barriers to progress will fall.”**

**Jill Burnett**  
Commercial Director, WaveDrives

**“This is a really exciting time for robotics, with breakthroughs in AI poised to make robots far more flexible and capable of helping with the dull, dirty and dangerous tasks that humans don’t want to do. But robotic bodies are lagging behind – physically, today’s robots look similar to those from decades ago. This programme aims to catalyse advances in robot bodies, specifically in the key area of manipulation, enabling robots to handle objects with the skill and dexterity that humans do.”**

**Jenny Read**  
Programme Director



Jenny Read is a visual neuroscientist, previously trained in theoretical astrophysics. Her work focuses on how we can build smarter bodies for robots through new modes of sensing, transmission of sensory information, and actuation through hardware advances. Jenny joined ARIA from her role as Professor of Vision Science at Newcastle University.

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# Future-Proofing Our Climate and Weather

Mark Symes  
Programme Director

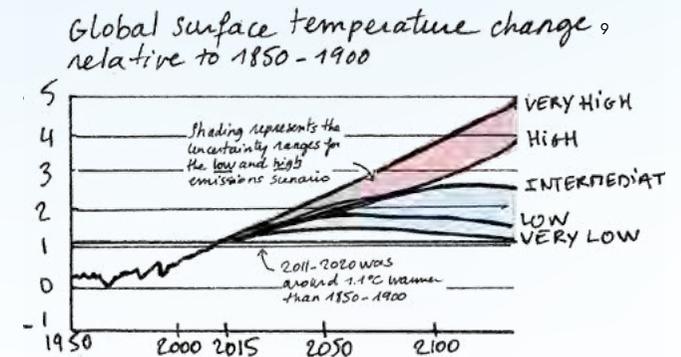
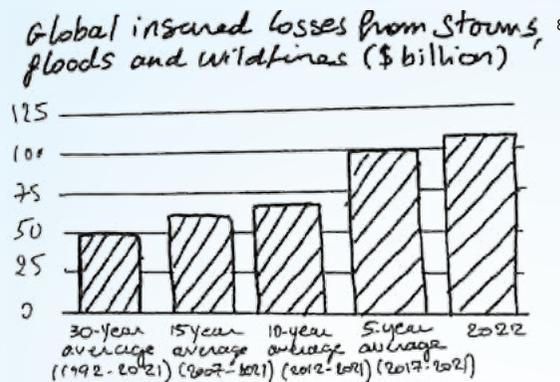
Even if we stopped burning fossil fuels tomorrow and no more CO<sub>2</sub> from human activity entered the atmosphere, the world would continue to warm due to the CO<sub>2</sub> already here.

The threat of extreme weather events like floods and hurricanes are only getting worse as global temperatures rise, and yet we currently have no technological tools to prevent these events or address the consequences of abrupt changes to our climate.

Building on Mark's 15-year career developing sustainable fuels in the drive towards net zero, we are exploring creating a new scientific framework to underpin technologies designed to prevent dangerous climate tipping points, and protect the planet and society from their consequences.

“Climate tipping points – like the melting of large ice sheets or sudden changes in ocean currents – have happened in the past. We don't know when the next one will be, and we currently have no options for how we might intervene quickly enough to avert disaster. We have a moral imperative to understand how they could be prevented.”

Mark Symes  
Programme Director



# Future-Proofing Our Climate and Weather continued



## Discovery

As part of his discovery process, Mark has visited institutions across the UK, including university labs in Manchester, Glasgow, Cambridge, and the Met Office. To understand the implication and perceptions of weather management technologies abroad, Mark has spoken to experts working internationally, including a CEO of an NGO working with the global south, a climatologist from Ghana and a professor from the Indian Institute of Science.

**“We need to think very carefully about options we might be able to develop to protect people and other ecosystems from the worst effects of climate change whilst we work extremely hard to get greenhouse gas levels down. Technology development in particular has really received minimal funding to date, and no other government has yet stepped up to help address this in the way that ARIA is doing so. With ARIA supporting this space it will also hopefully attract other funding agencies such as non-UK governments and trusts and foundations to do so.”**

**Shaun Fitzgerald**

FREng OBE, Director of the Centre for Climate Repair,  
University of Cambridge



Mark Symes is an electrochemist, with a 15-year career developing sustainable fuels in the drive towards net zero. He joined ARIA from the University of Glasgow, where he is Professor of Electrochemistry and Electrochemical Technology.

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# Endnotes

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working to unlock scientific and  
technological breakthroughs that  
can benefit everyone. It's a big mission,  
and getting there won't be easy.

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