THE AQUALUNAR CHALLENGE

A CHALLENGE PRIZE TO PURIFY LUNAR WATER

UK SPACE AGENCY

CHALLENGE WORKS
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INTRODUCTION

Tris Dyson

Founder and Managing Director of Challenge Works

This report summarises the activities and the impacts of the UK track of the Aqualunar Challenge, awarded in March 2025.

Challenge prizes have played an outsized role in the history of aviation and space.

Two decades ago, the Ansari X Prize launched the first private astronauts above the atmosphere.

NASA's astronaut glove challenge reinvented space suits.

The Canadian Space Agency (CSA)'s Deep Space Healthcare Challenge, awarded last year to the inspirational Dr Frederic Lemaire, created bold innovations in telemedicine.

And going back to the early 20th century, so many of the early records of endurance and distance in flight were broken thanks to prizes.

So it was appropriate, 105 years after Alcock and Brown made the first ever flight from Canada to the British Isles – winning the £10,000 Daily Mail Prize in the process – that the UK and Canadian space agencies joined forces with Challenge Works to launch the Aqualunar Challenge.

The Aqualunar Challenge is the first collaborative prize between the UK Space Agency and the CSA, and the first space challenge prize in British history.

It set innovators the task of inventing technologies suitable for use on the Moon, to purify the water ice found in the lunar soil.

We can now reveal the winning teams of the competition's UK track:

In first place:
SonoChem System, developed by Naicker Scientific Ltd.

In second place:
Filtered Regolith Aqua Neutralisation Kit (FRANK), developed by RedSpace Ltd.

In third place:
AquaLunarPure, developed by Queen Mary University of London

But just as importantly, we can also tell the story of the challenge prize, the people involved, and the legacy it leaves behind.

EXECUTIVE SUMMARY

Challenge Works is delighted to announce the successful conclusion of the UK Space Agency's The Aqualunar Challenge, the UK's first ever innovation challenge prize for the space sector. The challenge represents a collaboration between the Canadian Space Agency and the UK Space Agency, via the latter's International Bilateral Fund, with parallel tracks of the challenge running in the UK and Canada – offering opportunities for cross-country networking and peer-learning. This report presents the successes of the UK track, designed and delivered by Challenge Works.

In January 2024, the UK Space Agency challenged innovators to respond to the following statement:

> **The Aqualunar Challenge is calling on innovators to create innovative technologies for use on the Moon to remove contaminants found in lunar water. These technologies may also contribute to novel water purification technologies here on Earth.**

A challenge prize was deemed advantageous because it would respect the diversity of plausible approaches to lunar water purification that a traditional grant would necessarily limit – finalists employed electrochemistry, ultrasound, microfiltration, microwave radiation and various applications of heat and pressure in order to meet the judging criteria. Furthermore, the low barriers to entry typical of challenge prizes would be attractive to outsiders, helping build out the UK space sector and foster connections with other industries.

70 draft applications were tabled, of which 35 were eligible. In April 2024, expert technical assessors and a judging panel of prominent space, commercialisation and water industry experts whittled these applications down to 10 finalist teams. To develop their solutions, each finalist team received a grant of £30,000 and a rich package of technical, legal and business support, access to testing facilities, mentoring, and peer-to-peer and industry networking events.

In March 2025, after eleven months of intensive development and support, expert assessors, and the judging panel reconvened to measure the ten finalist solutions against nine criteria:

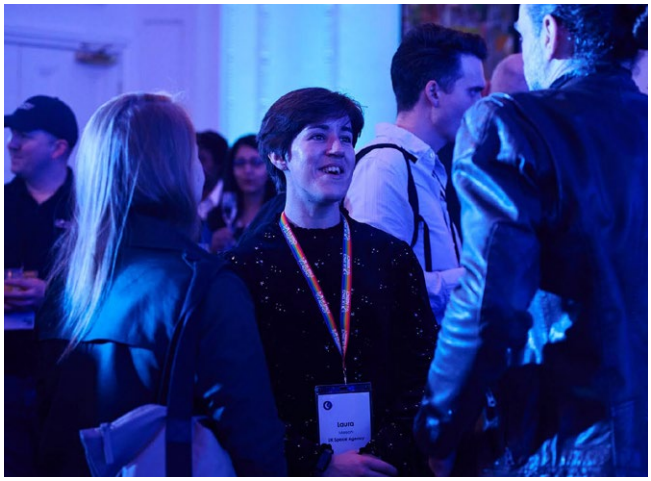
- Contaminant removal
- Appropriateness for mission scenario
- Reliability
- Solution adoption potential
- Efficiency
- Resource recovery
- Autonomy
- Monitoring
- Capacity to deliver

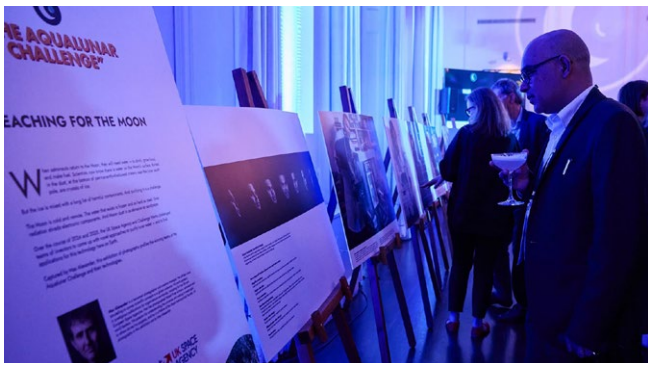
The eventual winner (SonoChem System, developed by Naicker Scientific), and two runners-up (FRANK from Redspace Ltd; AquaLunarPure from the Queen Mary University of London), were formally presented at the home of the High Commission of Canada in London on 27th March 2025, receiving subsequent grants of £150,000, £100,000 and £50,000 respectively.

Finalists interviewed in the making of this report, and throughout, expressed a high degree of enthusiasm for The Aqualunar Challenge – and challenges in general – as an approach to space sector innovation funding. As a diverse cohort, each finalist benefited from different aspects of the support package, but invariably claimed they had gained significantly from participation: either by developing new IP, gaining access to industry/funders, developing their commercial proposition or allowing them to establish/expand their UK presence.

Since undertaking the challenge, the winner, Naicker Scientific, has raised upwards of £230,000 in investment and their technology has been accepted onto a payload that will fly next year. Third-placed AquaLunarPure from Queen Mary University of London are launching a spin-out to commercialise their technology for water purification on Earth. Two teams have opened offices in the UK during the course of the challenge, and four finalists have entered the UK space sector for the first time. All finalists are actively interested in developing their technologies for either a space, water or mining industry application.

Grand Prize Winner: Lolan Naicker, SonoChem System from Naicker Scientific





1st place Runner-up: Team FRANK from RedSpace Ltd

2nd place Runner-up: AquaLunarPure from Queen Mary University of London

"The Aqualunar Challenge was set up to overcome one of the most significant obstacles to humans surviving on the Moon or other planets – the availability of clean drinking water.

By teaming up with our Canadian partners and harnessing the wealth of talent and creativity found across the UK, the challenge has uncovered a range of new ideas, including Naicker Scientific's SonoChem System.

Many of these ideas could not only fuel future space exploration, but also help improve lives and solve water shortages here on Earth – mitigating the impacts of climate change as we work towards a net zero future, a key ambition in our Plan for Change."

Lord Vallance, Minister of State for Science, Research and Innovation

A CHALLENGE PRIZE TO PURIFY LUNAR WATER

What is a challenge prize?

Challenge prizes are open competitions in which inventors compete to solve a problem – with cash prizes on offer for the best solutions.

Anyone can compete. Unusual suspects and maverick ideas are encouraged.

And unlike traditional science and technology funding, which places huge importance on track record and team expertise, challenge prizes reward results, even when they come from unexpected places.

That makes them a great way to get creative solutions to technical challenges like lunar water.

Since its foundation in 2012, Challenge Works has designed and delivered over 100 challenge prizes around the world.

Why lunar water?

With humankind returning to the Moon later this decade, purifying the water that exists on the Moon in ice is critical to enabling more ambitious space missions. Using lunar water – as drinking water, to grow food, to create oxygen and to split into hydrogen and oxygen for rocket fuel – is a key enabler for supporting future deep space exploration.

But this water is not pure, with contaminants preventing its use unless it is purified. And purifying that water in the Moon's harsh environment – at low temperatures, using minimal power, and without easy human access – is tough.

And purifying water in harsh, cold, remote environments, using minimal power isn't just a problem in space exploration. Water quality is in the news every week here on Earth, too. Thus, the prize also encouraged teams to consider how their technology could contribute to the environment here on Earth too.

The Challenge

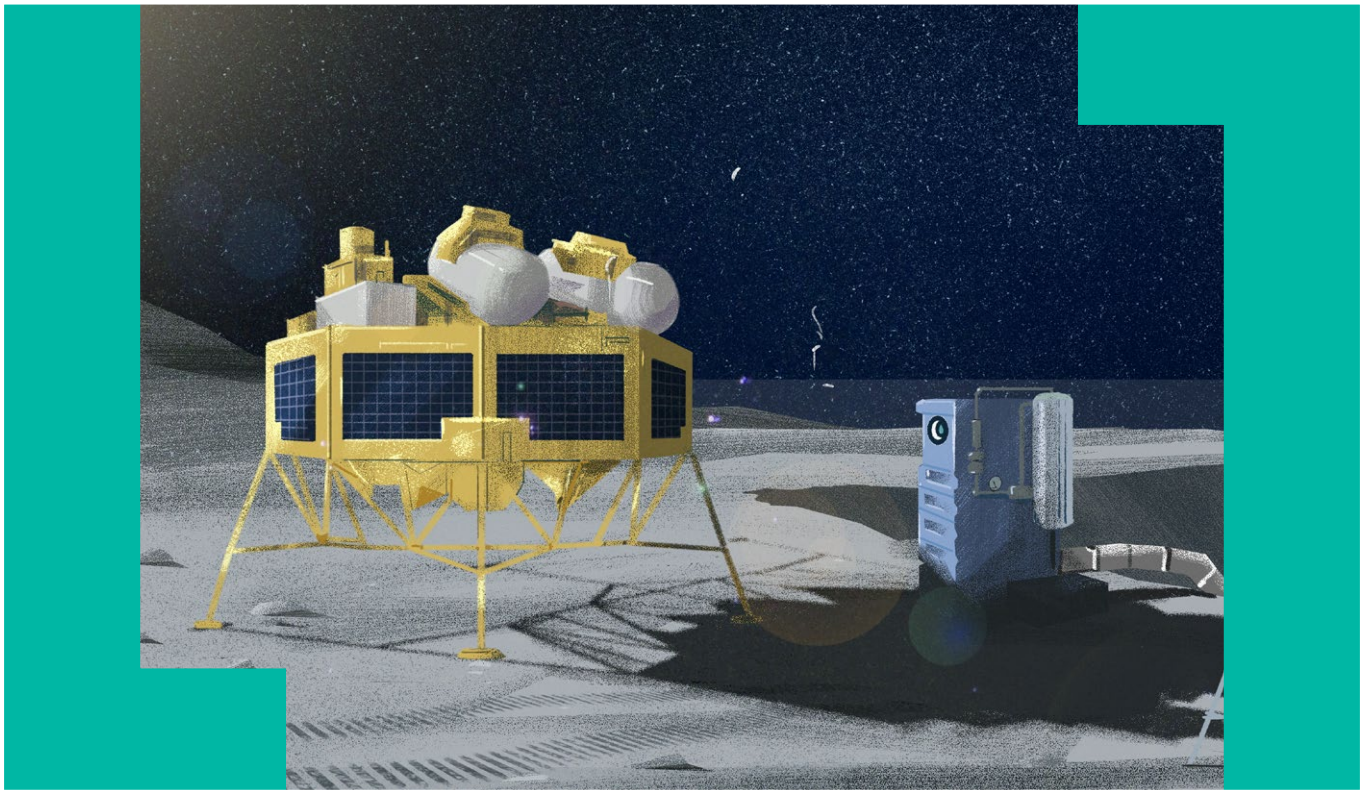
The Aqualunar Challenge was structured as two parallel competitions, one for British and one for Canadian inventors. Both shared the same challenge statement and criteria, though they varied slightly in structure.

The Aqualunar Challenge UK track offered £600k in financial incentives (plus a rich package of non-financial support) to inventors who could create innovative technologies that can purify water in this incredibly harsh environment.

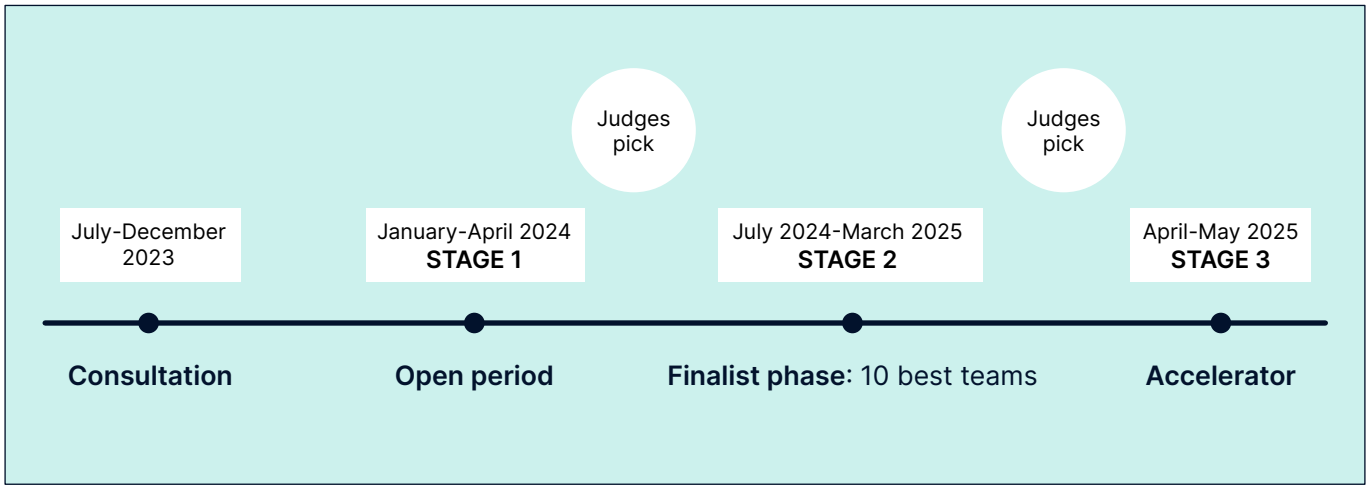
In the Aqualunar Challenge, teams were asked to respond to a simple challenge statement:

The Aqualunar Challenge is calling innovators to create innovative technologies for use on the Moon to remove contaminants found in lunar water.

These technologies may also contribute to novel water purification technologies here on Earth.



Aqualunar Challenge UK Track structure



Note that the Canadian track has a similar structure until March 2025, followed by a longer Stage 3 for four teams, in which they continue to compete for a single grand prize in early 2026.

In the UK track of the Aqualunar Challenge, teams first had to develop a proposal for how their technology would work, before the deadline in April 2024.

The top ten received £30,000 each and a package of non-financial support to develop this into a full design, components and (if possible) a working prototype by the final deadline in January 2025.

The top three won prizes of £150,000, £100,000 and £50,000 in March 2025, plus continued support with commercialising their solutions.

The decisions were made by a judging panel of prominent space, commercialisation, and water experts, supported by a panel of engineers and commercialisation consultants who reviewed the teams' evidence.

For both the finalist selection and the grand prize, teams were judged on 9 criteria:

- **Contaminant removal**: does the technology effectively remove the contaminants?
- **Appropriateness for mission scenario**: has it been properly designed for a lunar mission?
- **Reliability**: would it work reliably?
- **Solution adoption potential**: is there a market (in space or on Earth) for the technology?
- **Efficiency**: does it maximise outputs and minimise inputs?
- **Resource recovery**: does it recover the contaminants from the lunar water and allow their reuse?
- **Autonomy and monitoring**: can it operate remotely without human intervention?
- **Capacity to deliver**: does the team have the technical and commercial expertise to match their technological approach?.

The criteria were chosen to balance space and terrestrial use cases, engineering and commercial excellence, and technical performance of the solutions.

KEY FACTS AND STATISTICS

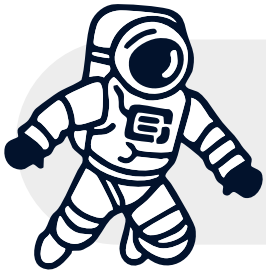
1 university new spinout company created

At least **1** collaboration in fund applications between innovators from the UK and Canada tracks

Over **70** drafts leading to **35** eligible applications for the challenge

10 finalist teams receiving seed funding and non-financial support

1 technology going to space



8 expert judges including 2 astronauts

Expert reviewers in **water**, **space**, **commercialisation**

10 in-person events

330 pieces of coverage in the media during the finalist phase, including The Guardian and BBC Newsround

4 firms entered UK space sector

Over 12,000 YouTube views

300 contact hours of non-financial support including webinars, events, expert support and mentorship

10 finalists shared **£300k** in seed grants

3 winners shared **£300k** of final prizes

THE AQUALUNAR CHALLENGE, MONTH BY MONTH

July to December 2023

Preparing for launch

The Challenge Works and Canadian Space Agency teams consulted with space and entrepreneurship experts to design the structure and programme of support for the Aqualunar Challenge, and prepare the challenge for launch.

January to April 2024

Challenge launches

The challenge prize was launched: following a press notice and public events, over 70 teams worked on applications with 35 eligible and complete proposals submitted at the deadline.

May to June 2024

Assessment and judging

Teams' applications were subjected to rigorous review by a team of assessors led by **Space Professionals**, with the best discussed in a day-long judging panel meeting chaired by **ESA Reserve Astronaut Dr Meganne Christian**.

July 2024

Finalists announced

Ten finalist teams were **announced at the Farnborough Airshow**, winning £30k each to develop their technologies.

There was widespread international media coverage of the challenge including profiles of all ten finalist teams in The Guardian, and coverage from BBC Newsround.

August 2024 to January 2025

Technology development

Teams worked on designing and refining their technology, and benefited from a range of technical and commercialisation support and site visits to space facilities and water industry events around the UK. One highlight was a visit to Isle Connect water industry event where teams were able to pitch their technologies to potential customers in the water sector.

November 2024

Innovator bootcamp

Innovator teams from both the UK and Canadian tracks of the Aqualunar Challenge **met at the Canadian Space Agency HQ in Montreal for three days of workshops**, networking and capacity development. Highlights included presentations from Canadian astronaut David Saint-Jacques, and Dr Frederic Lemaire, winner of the Canadian Space Agency's recent Deep Space Healthcare Challenge, as well as a visit to the Canadian Space Agency's Mission Control and Canadarm labs.

Spotlight on innovator support

Our innovator support delivery partners **Exotopic** and **Isle Utilities** delivered mentoring, advice, events and seminars to the finalist teams throughout the challenge, giving teams access to their vast networks and expertise across technology, commercialisation, space and cleantech.

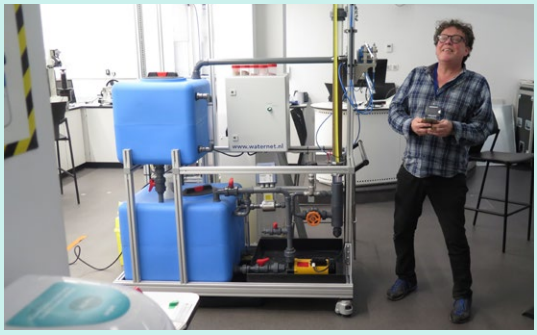
"I've done technical solutions before. It's really difficult to get products to market. But all of the softer aspects of participating in the challenge really gave me the ability and the opportunities to build up the business and put it on a different trajectory."

Lolan Naicker, winning team Naicker Scientific Ltd

January 2025

Final submissions

The final countdown: after a year of development, it was time for teams to write up their results in their final reports. For teams who requested it, the Aqualunar Challenge also arranged **testing at the University of Glasgow's vacuum chamber facility**.



February to March 2025

Assessment and judging

While teams benefited from a last burst of innovator support activities, including help with future bids and proposals, and pitch support, their final reports were reviewed by technical experts and the three winners were chosen in a day-long meeting of the judging panel.

27 March 2025

Award ceremony

Three winning teams were announced at a distinguished reception at the High Commission of Canada in London.

April to May 2025

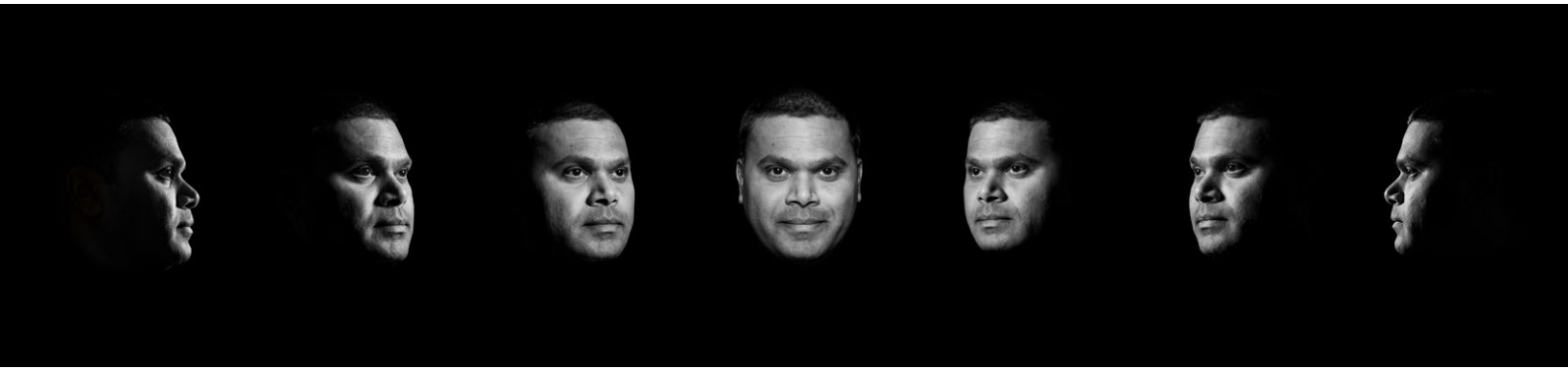
Winning teams

Three winning teams benefit from commercialisation, bid and pitching support to help their next steps on the path to growth.

"It's been fascinating to be part of a cohort of people. To be all working on the same thing, but with that slight element of competition there: that's been really interesting. Everyone's been quite willing to be open-minded and share some ideas, which has been good. I think that's been the most important part of the challenge prize model."

Shaun Fletcher, finalist team Lunasonic

THE WINNING TEAMS

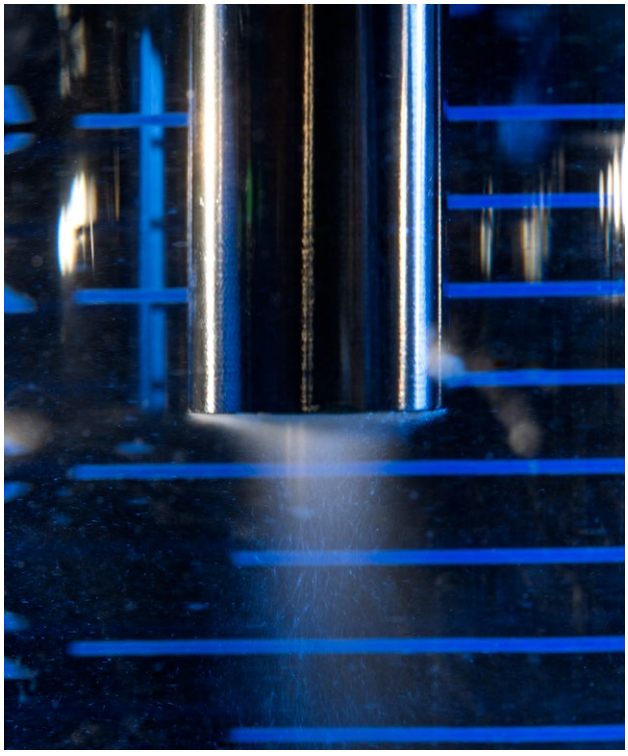


Lolan Naicker: The Seven Phases

Lolan Naicker and his engineering company, Naicker Scientific, is the winner of the Aqualunar Challenge. Lolan had not previously worked on lunar water purification, but with a background in chemical engineering and space sector engineering, he knew he was well placed to tackle this challenge.

Seven phases of the Moon, seven stages of SonoChem System's water purification process:

- **Regolith processing**: Low frozen water content lunar regolith is heated under vacuum to sublimate and separate volatiles from particles.
- **Volatile collection**: Sublimated volatiles are collected under vacuum and continuously fed into a high pressure vessel.
- **Phase separation**: Volatiles are subjected to a phase change under increased pressure and temperature conditions to produce liquid.
- **Sonochemical degradation**: Contaminated liquid water is subjected to ultrasound. This generates millions of tiny microbubbles which act as chemical microreactors. Upon bubble collapse, localised high temperature and high pressure conditions are created which break down contaminant molecules.
- **Potable water storage**: Purified water is stored in vessels for use by astronauts.
- **Off-specification water storage**: Water which does not meet drinking water standards is stored for reprocessing.
- **Reprocessing**: Off-specification water is gradually recycled and reprocessed.



Harnessing the power of microbubbles

Taking control

Grand prize winner

SonoChem System

Led by Naicker Scientific Ltd, Gloucestershire

Naicker Scientific Ltd is a cross-sector technical consultancy based in Gloucestershire with one principal contributor. Lolan Naicker had no proprietary technology or product of his own before the challenge. However, a background in chemical engineering, physics and space systems engineering as well as a wealth of experience working on various technologies across different industry sectors, positioned him well for lunar water purification.

The ambition of Naicker's design was to achieve continuous-mode water purification (as opposed to a batch-mode process). This was not a requirement of the challenge, nor was it necessarily instrumental to meeting a derived requirement, but Lolan knew that it is incredibly difficult to achieve continuous processing in a vacuum environment, and if he could, he would have something genuinely unique and valuable.

The opportunity and ambition to grow Naicker Scientific Ltd, in turnover, employment, reach, has always existed, Lolan explains, but he needed an opportunity that would kick-start that transition. Very explicitly, Lolan set out to leverage the challenge as that catalyst. He was confident in producing a good technical solution, but the networking, development and business support provided through the challenge helped him navigate new sectors, develop a growth plan for the business, and strategise a route to market for product ideas.

"I've done technical solutions before. It's really difficult to get products to market, but all of the softer aspects of participating in the challenge really gave me the ability to, and the opportunities, to build up the business and put it on a different trajectory"

Lolan Naicker, Naicker Scientific Ltd

Through the Aqualunar Challenge, Naicker Scientific Ltd has raised money to develop two spin-out product technologies, one of which will go into space as an in-orbit demonstration payload this year. Marks & Clerk has confirmed them to be patentable and has accepted them for discounted patenting costs. The media attention generated through the challenge – Lolan's live BBC radio interview and coverage in The Guardian – has led to a clear uptick in general technical consultancy work, including his first international contract with a Californian start-up. Monetarily, Lolan explains that "the money I raised over the last few months is a multiple of the historical average yearly revenue of the business." In short, the Aqualunar Challenge has transformed Naicker Scientific Ltd from one-person technical consultancy that had been "ticking over" for years into a technology development company which has its own IP, product development roadmap, has raised investment capital many times its value, and has advertised to hire its first full-time employees.

"I've worked on previous UK Space Agency grants, European Space Agency grants, Innovate UK grants. It's over a dozen grants that I've worked on over the past seven years, and this was by far the most value per pound that the taxpayer is getting from this grant. I definitely think that this is the way grant funding should be."

Lolan Naicker, Naicker Scientific Ltd

The judging panel said:

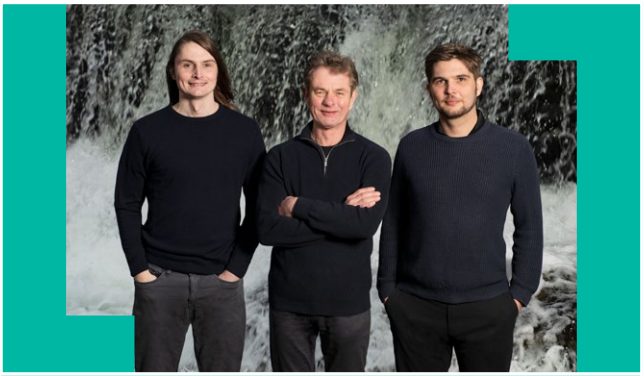
"This team has turned a £30k grant into two jobs and £231k income. I wish all government funds could work like that"

Mike Curtis-Rouse, Aqualunar Challenge Judge

First runner-up

FRANK: Filtered Regolith Aqua Neutralisation Kit

Led by RedSpace Ltd, South-East England



Michael Thompson and Sons, Paul and Daniel Thompson: A family affair
Taken at Richmond Falls, North Yorkshire

RedSpace is a firm based in the south-east of England specialising in deep space communications, spacecraft systems engineering and avionics. Previously, members of the team have developed proximity communications for the ExoMars rover Rosalind Franklin, and more recently for commercial lunar missions. In the Aqualunar Challenge, they saw an opportunity to secure significant funding, and to enter a promising new sector via an interesting technical challenge in which they had transferable expertise.

RedSpace set out with the intention to take robust, well-established technologies for terrestrial applications and focus on adapting them for lunar use. They thus built their system on elements at a relatively high TRL, and set out with two main development goals: to prove their design in a simulated vacuum environment, and in lunar gravity – by planning and conducting their own drop test.

As veterans of the space sector, RedSpace made less use of the industry connections offered as part of the challenge, but as a family team did appreciate the comparative ease and accessibility of applying for and participating in a challenge prize – having at the start been apprehensive that they might be the wrong fit, or an "outside bet".

> **"One of the key things is that this was very accessible, much more so than maybe we'd appreciated … I think it gave me confidence that probably, you know, if you've got a good idea, you don't necessarily have to have the full solution to be able to apply."**
>
> **Paul Thompson, RedSpace Ltd**

Paul notes that "some teams say success is in our DNA", whereas he, his father and brother say, "DNA is in our DNA."

They'd be inclined to apply for similar challenges in future, with the right focus. Unlike many teams, RedSpace sees the future of their innovation as located squarely within the space sector. Thanks to the prize funding, they plan to further develop FRANK with the ambition to create their own IP from the design, to commercialise it when the market is ready.

The judging panel said:

> **"They have great chutzpah: bold, unfazed and a totally refreshing approach. Great thinking about the lunar environment and NASA water standards."**
>
> **Paul O'Callaghan, Aqualunar Challenge Judge**

Second runner-up

AquaLunarPure

Led by School of Engineering and Materials Science, Queen Mary University of London

AquaLunarPure was created by a team of chemical engineering academics at Queen Mary University of London. In 2017, Dr Edo Boek and Prof Stoyan Smoukov established a new chemical engineering research group focused exclusively on sustainability rather than fossil fuels, a rarity in the UK and worldwide. The Aqualunar Challenge presented itself as an opportunity to combine two intellectual passions: water purification, and the propagation and sustenance of life on other planets and space, a focus of previous research.

The team's design centres on generating supercritical water, a frontier technology that is still maturing but holds enormous scientific promise, particularly with respect to water purification and decontamination. The design also includes an element that "remineralises" the water after purification. As part of the challenge, the team was able to send a PhD student to the University of Washington, a world-leading centre for supercritical minerals to further the development of the technology.

Edo Boek & Stoyan Smoukov: Three Steps, One Solution

Two things that especially impressed the team about being part of a challenge were the ease of application by comparison with the academic grant process, and exposure and connections that it provided. The team is very keen to apply for future challenge prizes as an alternative to traditional funding routes, especially in water purification.

> **"It's amazing that even though the cash outlay is relatively small, the extra benefits are actually very well thought out. Not just provided, but very well thought out. The publicity is unequal to other projects that we've had – we've had coverage in The Guardian, we've had coverage in some podcasts."**
>
> **Prof Stoyan Smoukov, Queen Mary University of London**

AquaLunarPure has had the ambition to spin something out of their work in the past, but not the opportunity. The Aqualunar Challenge has provided the team with the knowledge, connections and confidence (and potentially a client) to start their own company. They are looking mostly toward terrestrial applications, but have submitted a grant proposal with one of the Canadian teams to explore separating a contaminant (hydrogen sulphide) into hydrogen and sulphur – a valuable space capability for ISRU (hydrogen as fuel, sulphur as a binding agent).

The judging panel said:

> **"I'd be very happy to drink that water."**
>
> **Vanessa Speight, Aqualunar Challenge Judge**

Finalist

Titania-Diamond Annular Reactor (TiDAR)

Led by Nascent Semiconductor Ltd, County Durham

Nascent Semiconductor Ltd is a Durham-based SME specializing in high-reliability silicon carbide electronics for hostile environments. The Aqualunar Challenge presented itself as a "nice fit" and a good opportunity to apply their expertise to an interesting and "hands-on" challenge. While working on a parallel project focused on extraterrestrial water purification, Nascent benefited from the contributions of an intern, Abi, who played a key role in accelerating the early research phase.

TiDAR is essentially a two-stage, solid-state purification system that uses an electrolysis cell with a diamond semiconductor, and subsequently a photocatalytic cell, to break down the contaminants in water. Beyond the funding, and as experts in electronics but relatively new to other technical areas, the team appreciated being part of a cohort of innovators, sharing in a process of discovery and pushing the boundaries of their own expertise.

"You can get it into your own head that you don't know where this is going. But then you see all the other teams and they're going through the same thing. So I think a lot of those meetings where we had a chance to actually talk with other teams were really helpful."

Joe Riley, Nascent Semiconductor Ltd

The bootcamp in Canada fostered some connections with potential partners, particularly in terrestrial applications like water purification and mining. Access to technical mentors also helped

Titania-Diamond Annular Reactor (TiDAR) team

the team navigate less familiar chemistry-based aspects of their project. Nascent Semiconductor Ltd would be keen to take part in future challenges.

Looking ahead, Nascent Semiconductor Ltd plans to build on the momentum gained from the challenge, exploring both space and terrestrial applications of their technology. Across the North-East, commercial opportunities in mining, data and water are fairly abundant, and the challenge has focused their thinking on how to leverage these.

Technologically, the solution involves combining two techniques typically used for separating two different contaminants in a synergistic way, an innovation the team envisages being the basis of some future IP.

The judging panel said:

"A robust way to do oxidation in a hostile environment: chemical-free, a fundamental component for future water purification, with not a lot of moving parts"

David Saint-Jacques, Aqualunar Challenge Judge

Finalist

Ganymede's Chalice

Led by British Interplanetary Society, London

The British Interplanetary Society (BIS) can count itself as the oldest space Society in continuous existence. Since the 1930s, the vision and thought leadership produced by this membership organisation has had a formative influence on humanity's understanding of and journey in space. The Society and its journal specialise in publishing and promoting new ideas and early conceptual work supported by sound technical reasoning – so the Aqualunar Challenge was a natural fit.

The British Interplanetary Society's innovation, Ganymede's Chalice uses a form of mechanical agitation to create pseudoconvention within the regolith and to separate particles. Contaminants are then removed through a combination of vaporisation followed by fractional freezing. Powered by a solar concentrator, it is an elegant design which maximises the benefits of the Lunar environment and reflects the Society's interest in early-stage research and exceptional proofs of new concepts, rather than later stage developments using more mundane underlying technology.

Above all, the British Interplanetary Society appreciated the "openness" of the challenge – the freedom to approach the challenge from any angle rather than designing to spec. The opportunity to go to Canada and associate with other teams working on related technologies was "hugely motivating" and the webinars were extremely helpful for a membership organisation thinking about commercial possibilities.

Simon Feast and Philip Baldock demonstrate components of the Ganymede's Chalice solution

"Looking at both approaches to funding, it strikes me that a lot of the time, funded contracts can be far too specific and constraining. I look at some and my immediate reaction is something like 'okay, but that's the wrong way to do it.' Freedom to really examine the question that's being asked yields some pretty interesting ideas. So certainly at the early stages, I think challenges are very, very powerful."

Philip Baldock, BIS

The British Interplanetary Society has long focused on publishing research, thought leadership, and running events and networks, but its positioning as a launchpad for visionary ideas means that the notion of having its own technology has never been too remote. Aqualunar gave the team the footing to do this, and fostered ambitions for a spinout company that will be able to take the technology forwards.

The judging panel said:

"It's like the Da Vinci of water purification, it's just beautiful and fabulous. It's great end-to-end thinking, highly innovative, but we would love to see it demonstrated."

Mike Curtis-Rouse, Aqualunar Challenge Judge

Finalist

CLiVE: Cyclic Volatile Extractor

Led by Minima Design Ltd, Suffolk

Mimina Design Ltd is a Suffolk-based design agency that produces a remarkably diverse range of technical products and solutions – from elite sports equipment to medical devices and assisted living to industrial monitoring technologies. Minima Design's interest in space is long-standing but the Aqualunar Challenge marks its first, long-awaited foray into the sector. The team's design, CLiVE, uses a pressure-regulated heating chamber to separate contaminants from ice, leveraging phase changes to extract clean water efficiently in a lunar environment, then using tried-and-true microfiltration and reverse osmosis techniques for purification that maximise reliability.

Mimina Design can recommend the Aqualunar Challenge and innovation prizes more generally for two reasons. First, the non-financial support, particularly the networking events and professional support really helped to "get in the mindset of designing for space", and think seriously about the approach required to enter space and relevant terrestrial sectors. Second, the application process and financial support structure makes participation viable for smaller firms like Minima.

"The way the financial support has been arranged should be a blueprint for government funding streams, because it de-risks the process by having a small, relatively short application form and then a short-listing, and some funding for development. It takes away risk because when applying for other government funding, you could put three weeks into an application and then not be successful, so that time is wasted."

Andrew McCulloch, Minima Design Ltd

CLiVE's sleek and attractively-designed exterior hides a more flamboyant internal purification system that Minima hopes to be the proprietary technology at the centre of its future plans.

As an agency, Minima's primary business is in designing other people's solutions, but it has long been an ambition to have a solution of its own. The Aqualunar Challenge has begun that process – the support it provided as part of the programme has helped Minima to think about the pathway to a terrestrial application, and develop plans to patent its technology.

"Most of our previous work has been fee-for-service. So, we develop fantastic value for our clients, and they get the long-term rewards of that value. I've always wanted the company to have its own IP, an internal project where we can grow more value than we can just as consultants."

Andrew McCulloch, Minima Design Ltd

The judging panel said:

"The team is as passionate as they are innovative. Good end-to-end thinking – and we'd all like to take a CLiVE home with us."

Stefanie Moriarty, Aqualunar Challenge Judge

Finalist

Static Water Extraction System

Led by Interstellar Mapping Ltd, London

The proof is in the pudding: for Interstellar Mapping Ltd, there was only one scientific test that truly mattered.

Interstellar Mapping Ltd is an Australian start-up that specialises in lunar mapping. Its team had no prior presence in the UK, but spotted an opportunity in the Aqualunar Challenge to both develop a new technology and to establish themselves in a new market. With a background in oil and gas, and in rural Australia, Interstellar had a strong appreciation of designing for remote, inhospitable environments. Reliability is critical for lunar surface operations. The design prioritizes simplicity, minimizing the number of moving parts to enhance durability and reduce potential failure points. In essence, SWES uses a series of pressure seals and heating elements to sublimate and remove contaminant volatiles from the sample, then heats the regolith further to evaporate, extract, and finally capture the water.

Of the non-financial support, the team felt its mentor Andy Grey was a really good fit, and found the webinars useful, especially those dedicated to IP – they have developed some novel IP which is at the core of their immediate growth plans. Although the team is one of the more commercially mature in the programme, the professional support package was very well received and helped them polish its appeal.

"We're a bit like regolith itself. We're a little rough around the edges so it's good to get some professional help on all the different aspects of things."

Andrew Hazleton, Interstellar Mapping Ltd

The impact of the Aqualunar Challenge for Interstellar Mapping Ltd has been felt in two main respects. First, they entered the challenge with a sought-after mapping technology with clear lunar and terrestrial applications, and through it, they've been able to develop their purification technology as a secondary component, which significantly enhances their commercial proposition.

"We joke that our first million is going to come from the hardware that we've developed through this programme – our first billion is going to come from the map. But I'm a bit skeptical about that, because we're getting some traction with terrestrial partners as well as off-Earth partners with this hardware."

Nick Barnett, Interstellar Mapping Ltd

Second, the UK wasn't even "on their radar" before the challenge, but the Aqualunar Challenge has allowed them to gain a foothold – hiring two staff in London – and gain access to associated revenue streams and opportunities. Their partnership with University of Glasgow has led to some very early conversations with the Scottish government about a spin-out, and they openly discuss setting up a manufacturing facility in the UK.

The judging panel said:

"It's elegant in its simplicity. Robust, pragmatic and credible as a core element of a broader system, and with an impressive potential range of terrestrial applications."

Mahesh Anand, Aqualunar Challenge Judge

Finalist

I-LUNASYS: Innovative Lunar Water Resource System

Led by Perspective Space-Tech Ltd, London

Perspective Space-Tech is a space sector start-up founded by two students during their time at the Technical University of Berlin. The company specializes in developing spacecraft and systems capable of monitoring their own health, adapting to changes, and being easily repaired or modified, to ensure untroubled payload operations throughout the mission lifespan. This innovative philosophy of creating "living" rather than "dead" systems is central to their mission. Initially, Perspective Space-Tech focused on autonomous decision-making technologies for Earth observation satellites, but they recognized the Aqualunar Challenge as an opportunity to expand their expertise into the lunar economy by implementing their philosophy of living spacecraft.

Their system, I-LUNASYS, is designed to be standalone and self-sufficient, operating without external power or communications. It employs straightforward, fundamental chemical and physical processes to provide clean drinking water, aligned with Perspective's ethos of simplicity combined with intelligence. I-LUNASYS features a sensor network for monitoring performance, enabling predictive maintenance and enhancing reliability.

"There is a very famous saying associated with Kelly Johnson from Lockheed Skunkworks – an acronym K-I-S-S, meaning 'keep it simple and stupid'. This philosophy guides us as well, but we've taken it further. We didn't just leave our systems simple; we made them intelligent."

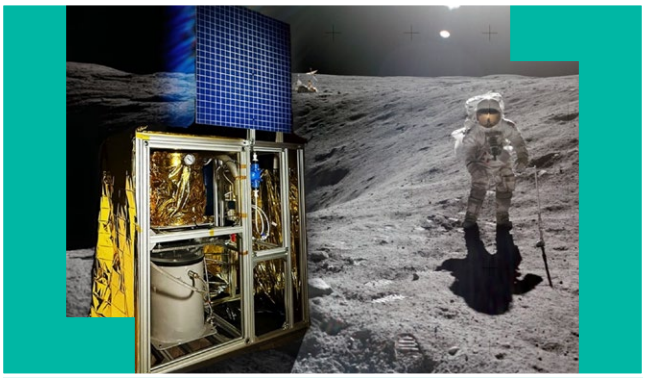
Prabhpreet Singh Data, Perspective Space-Tech Ltd

Financial support provided to the finalists allowed Perspective Space-Tech to expand its team by hiring a chemical engineer, complementing its existing expertise in the space sector and programming. Participation in the Aqualunar Challenge enabled the company to establish a permanent office in the UK at the Harwell Space Cluster. This strategic move, along with the credibility gained from the Aqualunar Challenge, has created significant new opportunities. Moving forward, the challenge has influenced the team's strategy to apply its adaptive spacecraft technology to critical lunar systems beyond water filtration. The team's ultimate ambition is to develop a demonstrator—similar to NASA's MOXIE—and successfully deploy it on the moon.

The judging panel said:

"Great modular and robust systems engineering, making good use of the cryogenic vacuum of the Moon. Great that it's designed with modularity in mind."

Meganne Christian, Aqualunar Challenge Judge

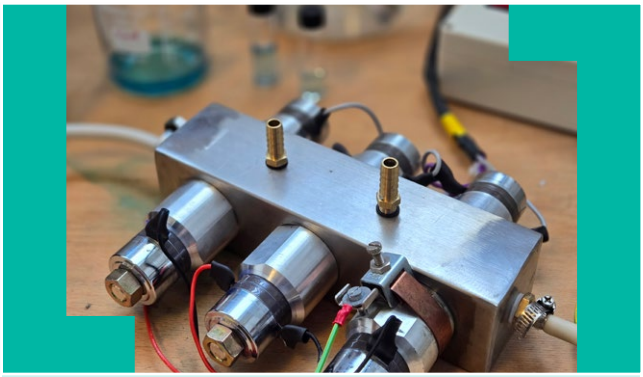


A representation of I-LUNASYS in operation on the lunar surface – the team have an ambition to build a demonstrator that would make this a reality.

Finalist

Lunasonic

Led by School of Chemistry, University of Glasgow



Lunasonic's compact prototype employing dual-frequency ultrasound forms the core of its Aqualunar technology, with promising water industry applications.

Lunasonic is a research team based in the University of Glasgow, focused on novel methods of energy conversion and storage. The team is led by PhD candidate Shaun Fletcher, and Dr Lukman Yusuf, with support from mentor Prof Mark Symes, and colleagues across chemistry, engineering and earth sciences. Before the challenge, they had published several research articles on using ultrasound to degrade pollutants in wastewater.

When they came across the Aqualunar Challenge, the team began thinking about how its technology could be applied to a completely different problem in a completely different setting. Lunasonic uses ultrasonic transducers to attack contaminants in lunar water with powerful acoustic cavitation. These can induce the rapid degassing of dissolved gases, oxidation of highly soluble pollutants, and the fluctuation of suspended lunar soil for easy removal.

The core challenge for Lunasonic lay in lunar adaptation – how to take its existing demonstrator in the lab and ensure the process itself is compatible with the lunar environment.

The standout benefit offered by the challenge for Lunasonic was being able to speak to people in the water industry who could explain what water companies and key players in the industry would want from a technology like theirs, in the context of new pollutants, tightening regulations, and capacity and energy requirements. More broadly, participating in a challenge prize helped the team to think in a driven way about developing an application, rather than just doing pure knowledge production. Doing so as part of a competitive cohort catalysed that development.

> **"I think what the challenge has done is helped us think beyond just getting results in the lab. As research chemists, our focus is largely on publishing papers, doing work at the lab bench. But as part of the challenge, the focus moves beyond doing things academically and thinking 'right, how do I actually develop something that can be deployed in the real world?'"**
>
> **Shaun Fletcher, Lunasonic**

Through the challenge, Lunasonic has developed a demonstrator prototype to approximately technology readiness level 4. They have the capability to remove contaminants from the water, and proof of concept to separate the contaminants in gas form once removed – a capability important for In-Situ Resource Utilization (ISRU). They plan to apply for future funding, with bid support from the Aqualunar Challenge. Lunasonic plans on exploring collaborations within the Aqualunar Challenge cohort (e.g. exploring ultrasound to help gaseous diffusion from electrodes in microgravity) and with connections made in Canada relating to its other research interests (e.g. ultrasonic production of fertilizer for sandponic agriculture in water-scarce regions).

The judging panel said:

> **"It's an elegant, frugal and robust method for purifying water on the Moon"**
>
> **David Saint-Jacques, Aqualunar Challenge Judge**

Finalist

RIPPLE: Regolith Plasma Purifier for Lunar Exploration

Led by Regolithix Ltd, West Yorkshire

Regolithix Ltd is a space sector start-up with a background creating air filtration systems for the aerospace industry. Its design uses a plasma torch to break down regolith at a molecular level, splitting out hydrogen, oxygen and other contaminants. This approach not only promises pure water but other nanoparticles which can be used in 3D printing and manufacturing, an important capability in space and on Earth.

Director Ed Cudworth notes that pursuing this approach pushed the team to expand into new technologies and expertises such as RF plasma generation. Participating in the Aqualunar Challenge provided Regolithix Ltd with essential support to advance its concept from early-stage research to a working prototype. The mentorship and collaboration with other teams proved invaluable, offering guidance on complex challenges and access to shared knowledge. Beyond technical support, marketing and legal resources, including trademark assistance, helped strengthen the team's commercialisation prospects.

"I think it really pushes you to develop your concept. I've been involved with funding rounds in various jobs, but they tend to take a bit of a slower pace, whereas this really pushed you to develop your solution. It pushes you to go outside your comfort zone."

Ed Cudworth, Regolithix

The challenge has taken RIPPLE from a concept to technology readiness level 4, a physical prototype they can test and develop. Regolithix Ltd has now partnered with a company specializing in regolith extraction, to which it will add its purification technology as the base application.

Moving forward, the team aims to secure additional funding, and is actively exploring terrestrial applications – especially in the water sector – as well as lunar ones. The main impact for Regolithix Ltd has been broadening its horizons as to the range of commercial opportunities open to the team, and opening the doors that will help pursue them.

The judging panel said:

"It's an original, disruptive and compact solution. It's got all the right foundations and is very promising for a space environment"

Paula Mills, Aqualunar Challenge Judge

The RIPPLE team, Ryan Wiseman (left) with Director Ed Cudworth (right)

AQUALUNAR CHALLENGE IMPACTS

The Aqualunar Challenge aimed to catalyse diverse technological approaches to lunar water purification while advancing terrestrial applications and creating commercial opportunities. It successfully brought together innovators from outside the traditional space sector, providing them with comprehensive non-financial support that built entrepreneurial capabilities.

Through UK-Canada collaboration, culminating in the Montreal innovator bootcamp, the challenge created lasting networks across national and sectoral boundaries that will continue to yield benefits beyond the prize period.

Breakthrough technologies

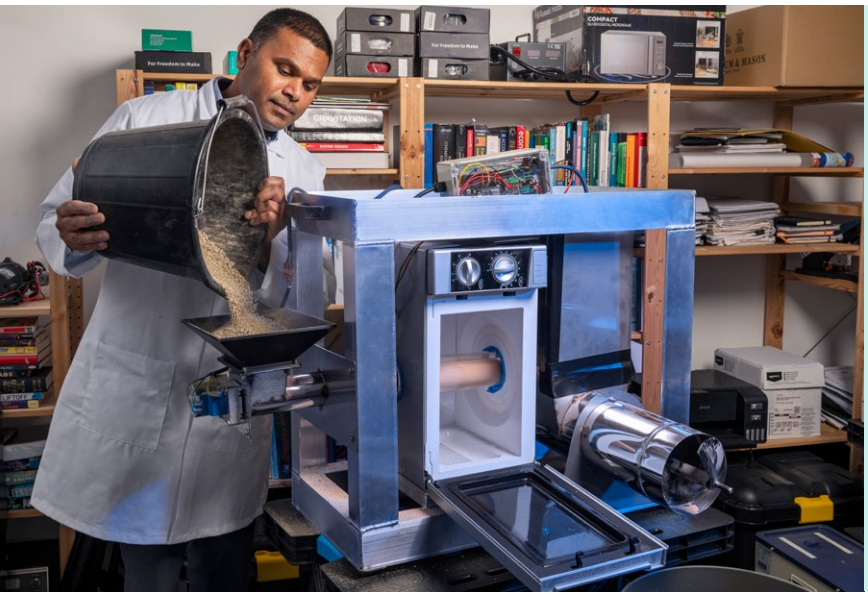
The Aqualunar Challenge generated a remarkable variety of technical approaches to water purification, creating a diverse portfolio of solutions. Technologies ranged from ultrasonic methods (SonoChem System and Lunasonic), to plasma purification (RIPPLE), to supercritical water oxidation (AquaLunarPure), to electrochemical approaches (TiDAR), as well as more conventional filtration and distillation systems.

What stands out about the challenge is how many of these technologies demonstrated immediate terrestrial applications alongside their lunar potential:

- Naicker Scientific Ltd's grand prize-winning SonoChem System secured over £231,000 in follow-on funding and contracts for industrial wastewater treatment applications.
- First runner-up RedSpace Ltd's FRANK system attracted interest from military applications.
- Second runner-up Queen Mary University of London's team AquaLunarPure is planning to spin out as PFAS-X, focusing on removing "forever chemicals" from water supplies.

Professor Mahesh Anand, a judge on the prize, highlighted this dual-purpose value:

"Many of the teams took on the challenge even though they don't work in the water industry while others didn't have space experience... we should encourage the teams to connect with each other so that they can accelerate their progress to the next level in developing innovative solutions for space or terrestrial applications."



From household appliances to moon tech

This prototype of a "lunar regolith processing" system has been built using a BBQ wood pellet feeder on the left, a domestic microwave oven in the middle, and an auger – a tool used to dig a hole for a fencing post – on the right, with building sand used as a lunar regolith simulant. The prototype was built to demonstrate the concept of continuous microwave heating of lunar regolith – merging two separate ideas investigated by NASA and the Open University.

Lunar regolith is fed into a hopper at the start of the process by a robotic system (in this case a human researcher), it is moved continuously via the pellet feeder through a microwave where it is subjected to efficient volumetric heating that drives off frozen water and contaminants leaving behind dry regolith. Dry regolith is continuously removed from the system and volatiles are directed to a secondary process for separation.

Thriving innovators

The challenge's non-financial support package was instrumental in transforming technical innovators into entrepreneurs. This support included:

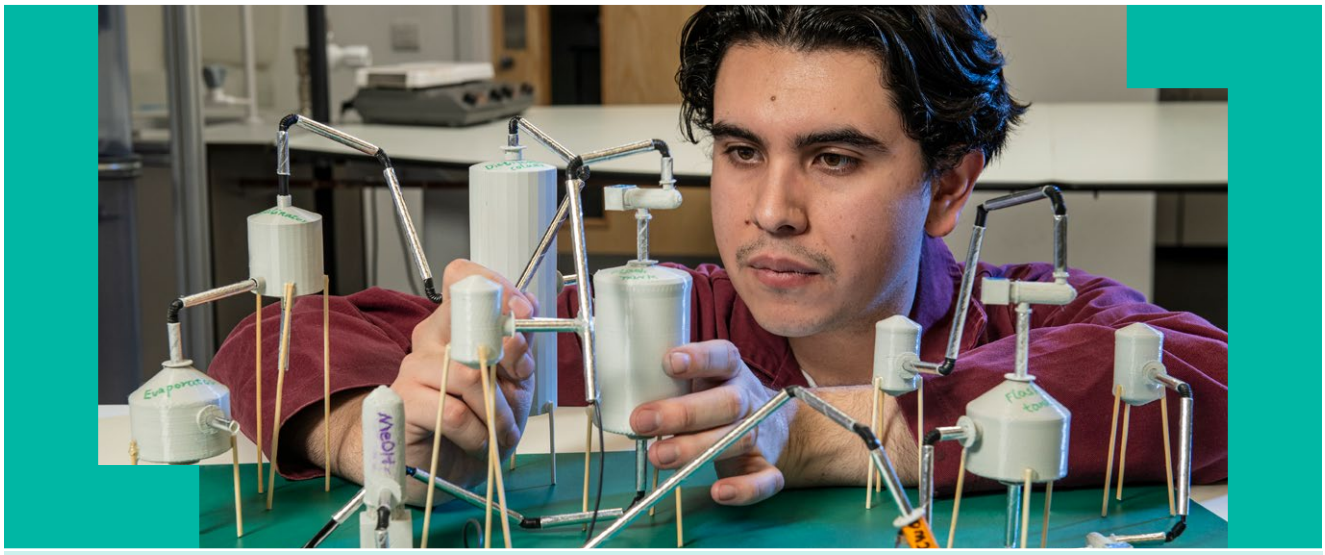
- One-on-one mentoring from industry experts.
- Technical workshops and site visits to space facilities in the UK and Canada.
- Commercialisation support, including IP protection and business development.
- Access to testing facilities, including vacuum chamber testing at the University of Glasgow.
- Connections to potential customers through water industry and humanitarian sector events.
- Travel bursaries.
- The Montreal innovator bootcamp for UK and Canadian teams.

Shaun Fletcher from finalist team Lunasonic emphasised how this comprehensive support expanded their horizons: *"We've had opportunities to meet key people both in the space industry and in the water industry. To get a broader picture of the state of play just now in those industries was fantastic."*

Lolan Naicker, lead on the grand prize winning solution, SonoChem System, noted the tangible business outcomes his company achieved thanks to the challenge: *"We have had media attention convert into actual consulting contracts. It's improved the revenue generation capability of the company and that's just within a short time frame."*

The challenge proved particularly effective at supporting innovators who had technical backgrounds but limited experience in commercialisation of the space sector.

As Andy Grey, CEO of Exotopic, which delivered many of these innovator support activities for the challenge, explains: *"We've been trying to encourage a sustainable long-term view as well. So not just, 'how do I win the challenge', but 'how do I actually create something that has longevity beyond the challenge'."*



Scaled down

Farid Bustos Jimenez examines a 3D-printed model of all the components of the team's AquaLunar treatment plant, which includes three essential "unit operation" steps in sequence: Evaporation, Distillation, and Super-Critical Water Oxidation (SCWO). The system would be packed into a single container and buried 50 cm below the surface of the Moon for protection and insulation. It is designed to operate autonomously, and to continuously transform dirty lunar ice into ultra-pure water. After purification, minerals are added back to meet storage and drinking standards.

International collaboration

The Aqualunar Challenge was delivered as part of the UK Space Agency's International Bilateral Fund, which is a flagship UK Space Agency programme that seeks to strengthen the UK space sector's international partnerships. The objectives of the IBF are to build stronger relationships with priority countries and become a trusted space partner of choice, increase UK space sector inward investment and exports and develop UK capabilities in collaboration with our international partners.

Canada is a key strategic partner for the UK and the Aqualunar Challenge has helped enhance collaboration between the UK and Canada at several levels, at the government-to-government level, UKSA-to-CSA level and between scientific communities in both countries. This challenge delivers against UKSA's international partnership objectives by developing the global influence, reputation, and championing of the UK space sector. The Challenge delivers on international priorities but also on UK space sector thematic priorities through the focus on lunar exploration (ISRU).

The Montreal bootcamp in December 2024 emerged as a highlight of the UK-Canada collaboration. This three-day event brought together finalists from both countries, creating a unique environment for knowledge exchange and relationship building.

Key elements of the bootcamp included:

- Presentations from Canadian astronaut David Saint-Jacques.
- Tours of the Canadian Space Agency's Mission Control and Canadarm labs.
- Structured networking activities between UK and Canadian teams.
- Workshops on commercialisation and technical development.

Vivian Harbers, Impact Canada Fellow at the Canadian Space Agency, emphasised the effect of this collaboration: *"When we're partnering with other organisations and we're able to cross-post and amplify one another's work, we can reach a wider audience, which in turn helps generate more awareness about both of our tracks of the challenge."*

The bootcamp has already catalysed at least one formal UK-Canada collaboration, with one Canadian team partnering with a UK team on a joint funding proposal. Several other cross-border connections between innovators are in development.

This international dimension added significant value to the challenge, providing perspectives, networks, and opportunities that would have been impossible in a solely UK-focused programme.

Building the UK space sector

One of the principal advantages of an open-innovation prize based on an accessible and relatable challenge with terrestrial overlaps is how it facilitates entry into the UK space sector.

Interstellar Mapping had no intention of coming to the UK. The Aqualunar Challenge gave them a reason and a foothold, and they now have two staff in London. Their partnership with the University of Glasgow has led to conversations with the Scottish Government about a spinout, and they openly discuss setting up a manufacturing facility in the UK. Crucially, they now have access to ESA and other funding streams, which if secured, would go back into the UK ecosystem.

Perspective Space-Tech were also globetrotters, originally founded at the University of Berlin, but during the challenge have opened a permanent office in the Harwell Space Cluster.

More broadly, four of the ten finalists, including one runner-up, were not active in the space sector before the challenge: three have plans to stay. By the same token, those with space sector experience have built bridges in the other direction – to the water industry, mining or industrial engineering.

Legacy and future impact

As the Aqualunar Challenge is concluded, the winning teams will continue to receive a further two months of non-financial support from Exotopic, Isle Utilities and Frazer-Nash to support their transition out of the prize programme.

Cally Walker, project manager for the UK Space Agency's International Bilateral Fund, believes that this challenge has lessons learned for the space agency. "The non-financial support worked very well, such as, sector engagement, educational capacity building and the champion in space element of what the programme has achieved. It would be good if we could also include the successful elements of this challenge in other programmes"

Judges, assessors, mentors and partners of the Aqualunar Challenge have suggested continuing the collaboration between the innovators after the end of the programme. The innovations and technologies produced in the challenge can be complementary and learn from each other in a way that generates better solutions, particularly once the heat of the competition is off.

"Once the competition ends, the real journey begins—collaboration between these innovators could unlock the next breakthrough in lunar water extraction. I'd love to see that!"

Mike Curtis-Rouse, Aqualunar Challenge Judge

The Aqualunar Challenge was designed with long-term impact in mind, focusing not just on immediate technological outcomes but on building lasting capacity and networks. As indicated by the strong commercial traction already achieved by several teams, the challenge's impact will continue to unfold in the years ahead.

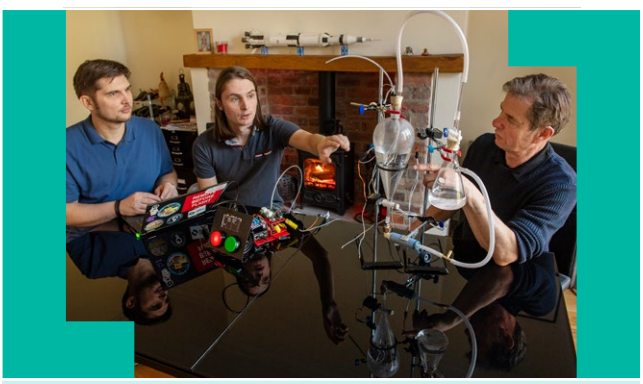


Table-top innovators

JUDGES

The Aqualunar Challenge finalists and the three grand prize winners were chosen by a panel of eminent experts in space, water and commercialisation.

Judging Panel Chair: Meganne Christian

Meganne is a Reserve Astronaut, and Exploration Commercialisation Lead at the UK Space Agency, and has been selected as a member of the European Space Agency's astronaut reserve. She has a background working as a scientist at the Concordia station in Antarctica and is passionate about the future of space-based systems, technologies, and applications.

David Saint-Jacques

Engineer, astrophysicist, physician and pilot, David Saint-Jacques is an astronaut with the Canadian Space Agency. In 2018, David flew as co-pilot of the Soyuz MS-11 rocket to the International Space Station, where he lived 204 days and worked as flight engineer and crew medical officer of Expedition 58/59. There he conducted numerous scientific experiments, performed a spacewalk and used Canadarm2 to berth a visiting spacecraft.

Mike Curtis-Rouse

Mike is at the forefront of advancing commercial space exploration as the Head of In-Orbit Servicing and Manufacturing at the Satellite Applications Catapult. His mission is to position the UK as a global leader in commercial space endeavours, driving innovation in robotics, in-orbit servicing, manufacturing, and propulsion technologies. Outside of Catapult, he is the CEO of Second Star, a new space propulsion company manufacturing high performance sustainable rocket engines for launch and in-space.

Vanessa Speight

Vanessa is a professor of Integrated Water Systems at the University of Sheffield, specialising in drinking water quality transformations including treatment processes, storage and distribution. Her research spans hydraulics, microbiological constituents, and chemical contaminants in complex socio-technical urban water systems, to design and innovative sustainable water systems of the future.

Paula Mills

Paula is an expert in Lunar mission planning, operations, and ISRU (In-Situ Resource Utilisation) activities, with a focus on space power applications beyond Earth. She specialises in spacesuit engineering for Extravehicular activity (EVA) operations, particularly in propulsion design and serves as a member of the UK node of the NASA Solar System Exploration Research Virtual Institute (SSERVI) panel.

Mahesh Anand

Mahesh is a Professor of Planetary Science and Exploration at The Open University, UK, specialising in the formation and evolution of planetary bodies in the solar system with a focus on Earth, the Moon, Mars and asteroids. His research interests centre on physical and chemical processes as revealed through the analysis of planetary samples, with a particular emphasis on the topic of water in the Moon. He is also a member of multiple international consortia focused on the origin and evolution of volatiles in the inner Solar system and the in-situ resource utilisation of planetary materials.

Paul O'Callaghan

Water scientist, sustainability thought leader and documentary producer, Paul O'Callaghan believes the global water crisis can be solved in his lifetime and he is on a mission to help make it happen. Paul is the CEO and Founder of BlueTech Research, focusing on advancing water management technologies. Paul holds a PhD in Water Innovation from Wageningen University and will soon be publishing his book 'The Dynamics of Water Innovation'

Stefanie Moriarty

An accomplished strategic marketing and innovation partner, Stefanie brings commercialisation and route to market expertise to the judging panel. She has developed and launched physical products, digital platforms and technical solutions from within start-ups, incubators and global giants, and has advised on innovation and product development strategies showcasing a breadth of industry insights. Stefanie has deep experience in early-stage concept development, translating user needs into product requirements, assessing product market fit and solution adoption potential, developing winning value propositions and testing alternative routes to market.

Spotlight on assessment partner

Space Professionals

The judges were supported by a panel of experts in space engineering, water engineering and commercialisation, convened by our assessment partner Space Professionals.

Space Professionals had two roles. For stage 1, they were responsible for shortlisting the most promising teams prior to the judges selecting the finalist teams. This exercise also generated feedback that was shared with all applicant teams, ensuring that even those who were unsuccessful in being selected as finalists were able to benefit from detailed expert review of their approach.

For stage 2, Space Professsionals carried out an independent review of teams' final reports and carried out an interview with the team leaders, in order to produce a technical report to support the judges' deliberations.

AFTER AQUALUNAR: FUTURE PRIZES?

At its heart, the Aqualunar Challenge has been about building, populating and strengthening the space sector ecosystem through innovation. That ecosystem is still growing, and there are still many innovation problems to unlock.

As well as progressing innovators and their ideas, the Aqualunar Challenge has provided fertile ground for like-minded, diversely-situated space professionals to strategise about the future of space innovation. Throughout the programme, Challenge Works has sought the expertise of the finalists, assessors, judges, support partners and other stakeholders on how to build on the successes of the Aqualunar Challenge. They were only too keen to share ideas for what should come next.

The list of promising challenge ideas for this fast-evolving sector is, predictably, long. On judging day alone, the judges devised a slate of possibilities, connected to space tourism, open space data, AR and VR astronaut training, aluminium extraction and smelting, end-to-end self-sufficient ships, future healthcare, autonomous construction, sustainable space habitation and debris clearance.

Five possibilities continued to crop up in the conversations about future prizes that Challenge Works had throughout the delivery of the Aqualunar Challenge. These are presented below, as a conversation starter for what the UK's next space prize could be.

Satellite Applications Challenge

Challenge: Two approaches:

Approach 1: **Set up the use case: 'develop an innovation to track emissions/detect road traffic accidents/monitor NHS estate'.**

Approach 2: **Let innovators come with use cases: 'develop an innovation that contributes to one of the UK government's five missions and which improves public services'.**

Opportunity: A major UK space space objective is to capture the European commercial small satellite market. As the UK progresses towards its first successful satellite launch from UK soil, there is a concurrent need to build the market itself: to develop new applications for satellite data, to generate awareness of the opportunities of satellites for terrestrial use, and bring new people, players and industries into the space sector.

Innovators: UK firms from any sector: healthtech, agritech, climate tech, construction, shipping, environment, sustainability, aviation, logistics.

Notable Features:

- Access to satellite data for testing.
- Expo or market-building exercise to showcase the opportunities and applications.
- Innovators become 'ambassadors' for space in their own target sectors.

Outcomes:

- Build bridges to terrestrial sectors.
- Upskill a space workforce.
- Cultivate awareness of the value of space for terrestrial purposes (build a market).

Lunar Algae Challenge

Challenge:

- **Contribute to the development of the first life cycles on the Moon by building a closed system for growing algae on the Moon.**

Opportunity: Algae photosynthesise in water and excrete oxygen, and are thus seen as the key that could unlock the oxygen production for human habitation and the development of life cycle processes on other planets/objects.

Innovators: Biochemists, marine biologists, agricultural scientists, and engineers.

Notable Features:

- Diverse innovators from different industries, with low barriers to entry.
- School outreach: run a parallel prize getting schoolchildren to use the prototypes to grow algae.

Outcomes:

- Connect space sector with agritech and biosciences.
- Advance another step in the chain of space organics: water, oxygen, microbes, plants, foods.

Microgravity Challenge

Challenge:

- **Develop a process to crystallize a new compound in microgravity that has novel uses in medicine, manufacturing or sustainability.**

Opportunity: The presence of gravity has profound effects on the way molecules behave and compounds form, and thus microgravity transforms the range of opportunities available to chemists for drug development, chemical engineers and manufacturers.

Innovators: University teams, start-ups, maybe larger firms (e.g. chemical engineering or manufacturers). Obvious sectors include pharmaceuticals, textiles, agriculture, fuels, climate science (e.g. coolants).

Notable Features:

- Finalist teams awarded time on parabolic flights.
- Microgravity testing in space, alongside final prize, for the winner.

Outcomes:

- Build bridges to terrestrial sectors, including closer links between space and health sector.
- Cultivate awareness of the value of space for terrestrial purposes, helping to build a market.

Occam's Toolbox Challenge

Challenge:

- **Using the smallest number of the simplest possible parts, at the lowest mass, with the least complexity, and the greatest range of potential uses, design a combination of a) an orbital robot, and b) a standard toolkit of parts, for construction of large structures in space.**

Opportunity: A major breakthrough in space innovation that many actors are chasing is the capability to manufacture, assembly and service in-orbit. Given the diversity of large forms we might build in space, the opportunity for a standard, maximally simple, cheap and versatile system of construction or designing and manufacturing diverse structures will be no less pressing than it is on Earth – perhaps more.

Innovators: A wide pool of material designers: industrial and product designers, engineers, construction firms... as well as established satellite design companies.

Notable Features:

- Focus on best design at schematic level means low technical barriers, leads to radically open challenge.
- Select the winner at a demo/test day where finalist teams are given a task(s) (e.g. design a solar array) to demonstrate the capability and versatility of their solutions.

Outcomes:

- Make UK firms gatekeepers to the coming era of in-orbit construction.
- Bring a really diverse class of professionals in the space sector.

Dexterous Manipulator Challenge

Challenge:

- **Create a dexterous robotic manipulator suitable for use in space to carry out a range of in-orbit servicing, assembly and manufacturing (ISAM) tasks.**

Opportunity: Manufacturing, maintaining and servicing in-orbit often requires human intervention because humans, even trapped in clumsy space suits, are more dexterous than robots. Creating advanced robotic hands – through novel hardware, sensors and software – that could carry out dexterous tasks involving tools and wires would be a game-changer for space sustainability.

Innovators: The challenge would focus primarily on attracting teams of roboticists, both in research institutes and in the commercial sector, who do not currently focus on space applications of their technology.

Notable Features:

- Qualifying prizes would focus on demonstrating key capabilities, such as manipulating flexible wires, operating tools and precision fine manipulation of components.
- The grand prize would be awarded for successfully completing a complex ISAM task that only humans can currently perform.

Outcomes:

- Unlock new capabilities in the space sector.
- Drive greater sustainability through repairability in space.
- Support advanced robotics capabilities on Earth.

Taking control

This experimental setup of a sonochemical reactor system has been built using laboratory grade equipment to create controlled conditions for testing. This photo shows the power and control electronics (white box) which drives an ultrasound transducer (blue and silver) producing acoustic waves in water. The probe is inserted into a sample of contaminated water, which is held at a controlled temperature in a jacketed beaker.

The drop test

The trio fully assembled and drop-tested FRANK, allowing them to simulate lunar gravity (1/6 of the Earth's!) to ensure the distillation stage functioned correctly under these conditions – with data collected and displayed. The test utilised a novel weather balloon approach, which involved a helium-filled weather balloon positioned 50 meters above the ground, with the test rig being dropped using a pulley and line system.

Taking control

AquaLunarPure's Foam Fractionation technology offers a groundbreaking solution to eliminating PFAS – 'forever chemicals' – from Earth's water sources. These chemicals, which are increasingly present in water, need to be purified to levels under 4 parts per trillion — essentially a drop in the ocean. On the Moon, AquaLunarPure utilises supercritical water at extreme temperatures and pressures to break down contaminants. By replicating these extreme conditions on Earth, the team concentrates PFAS in foam and uses reactive radicals to disintegrate them, turning them into harmless atoms. Edo Boek and Stoyan Smoukov have co-founded the spin-out company PFAS-X, to commercialise this purification process on Earth.

ORGANISATIONS AND ROLES

Funder: UK Space Agency

The Aqualunar Challenge is incredibly grateful to the **UK Space Agency**'s International Bilateral Fund for providing funding not only for the final prizes and finalist grants, but for the delivery of the challenge, ensuring a first-class programme of innovator support and profile-building activities were provided.

Project lead: Challenge Works

Delivery of the Aqualunar Challenge was led by **Challenge Works**. Challenge Works, part of the innovation foundation Nesta, is a social enterprise dedicated to running technology and social innovation challenge prizes around the world. Challenge Works led the design of the competition, engaging with experts and stakeholders, built and coordinated the consortium of delivery partners, ran the digital communications, outreach, assessment and judging process as well as administering events, grants and contracts.

Delivery partners and supporters

- **Innovator support delivery partners**: For delivery of the programme of innovator support, we relied heavily on **Exotopic** and **Isle Utilities**. They provided our innovator teams with an impressive array of industry mentors, valuable seminars, site visits, technical testing and much more.
- **Public relations**: Challenge Works' in-house communications team and UK Space Agency's communications team benefited from our long-running public relations partners **Seven Consultancy**, who secured high-profile media coverage for the teams and for the challenge as a whole.
- **Assessment partner**: Robust assessment and review are critical for a credible challenge prize process. Our assessors were sourced from **Space Professionals** and their network of consultants including Deos Innovation and Water Research Centre.
- **Pro-bono supporters**: We were honoured to receive in-kind support from a range of organisations including innovator support from **Weir Group**, free membership for teams from UK Space, pitching opportunities for winners from **Frazer-Nash**, legal support for teams from **Marks & Clerk** and a wonderful venue for our final event from the **High Commission of Canada**.

Aqualunar Challenge Canada Track

In parallel to the UK track, our colleagues at the **Canadian Space Agency**, in partnership with **Impact Canada**, were delivering a high-quality challenge for their teams too.

In our work together – on shared aspects of prize design, communications and non-financial support – we could not have hoped for better collaborators.

CHALLENGE WORKS
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