Heat Is the New Constraint in Orbit: Who Will Build the Radiators of the Space Economy

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Executive Summary

Heat is a hard limit in orbit: In a vacuum, a spacecraft can shed heat only by radiating it. The International Space Station's main cooling system needs about 475 square metres and almost 7 tonnes of radiators to reject 70 kW, roughly 7 square metres and 96 kilograms per kilowatt. At that performance, one megawatt would take about 6,800 square metres and nearly 100 tonnes, some $145 million just to launch (Section 2).

Demand is rising on two fronts: There are more satellites (16,913 active in September 2026) and each uses more power, with European telecom satellites carrying more than ten times the power they did in 1990. On top come on-board computing and the first orbital data centres, from Starcloud's H100 in orbit to Google's Project Suncatcher (Section 3).

Capital is not following the constraint: The four thermal start-ups we profile have disclosed about $25 million between them, against $420 million raised by Starcloud in 2026 alone; global space-venture investment reached €11.7 billion in 2025, most of it in launch and satellites (Sections 5–6).

Start-ups can win in components and materials: Deployable radiators, adaptive coatings and parts of active cooling loops are the segments most open to newcomers; heat pipes are protected by qualification barriers, and heat pumps still have no commercial entrant (Sections 4 and 6).

Exits run through M&A, and the largest values sit beyond space: 86% of space start-up exits between 2000 and 2020 were acquisitions, and thermal deals so far are small ($17 million for Roccor, €19 million for IberEspacio). The large values sit with players that reached markets beyond space, such as Boyd Thermal, acquired by Eaton for $9.5 billion (Section 7).

Risks: The main risks are that orbital data centres remain hype, that qualification cycles delay revenue, that customers are few and concentrated, and that primes build thermal systems in-house (Section 8).

01 Introduction: The Paradox of Orbit

In orbit, energy is abundant: the Sun shines almost without pause and solar panels harvest it with no clouds in the way. Yet switch on a powerful computer up there and it can overheat within minutes, because there is no air to carry its heat away.

This paradox is becoming a business question. As more power goes into orbit, getting rid of the resulting heat turns from an engineering footnote into a limit on what can be built. This article asks who will solve that problem, and where value will be created. We explain the physics (Section 2), why the problem is urgent now (Section 3), where start-ups can compete (Section 4), where capital is and is not going (Section 5), which companies to watch (Section 6), how investors could get their money back (Section 7), what could go wrong (Section 8) and what this means for investors (Section 9).

02 The Physics Problem, Explained Simply

Picture a vacuum flask. Your coffee stays hot for hours because there is a vacuum between the two walls: with no air, heat finds it very hard to get out. A satellite lives inside **a vacuum flask the size of the universe**.

Almost all the electricity a satellite uses, whether for a computer or an amplifier, ends up **turning into heat**. On Earth, the surrounding air or water carries it away: the fan in a laptop, the water pipes in a data centre. This is called convection. In space there is no air or water outside the satellite to take the heat away: fluids circulating on board can carry it from the electronics to the outer surface, but no further. From there, only one route is left: letting the heat escape as infrared light, invisible to the eye, just as a heater warms a room without touching anything. This is **radiation**, and the panels that do it are called **radiators**.

How much heat can a radiator 'throw out'? It depends on how big it is and how hot it is: this is the Stefan–Boltzmann law. Temperature matters enormously: a radiator at twice the temperature (counting from absolute zero, $-273\,°C$) gets rid of **sixteen times as much heat** [2]. The catch is that the radiator must stay cooler than whatever it is cooling, otherwise heat will not flow towards it. And computers and on-board electronics work poorly if they get too hot. So radiators operate at modest temperatures, and to shed more heat there is only one way forward: **make them bigger**.

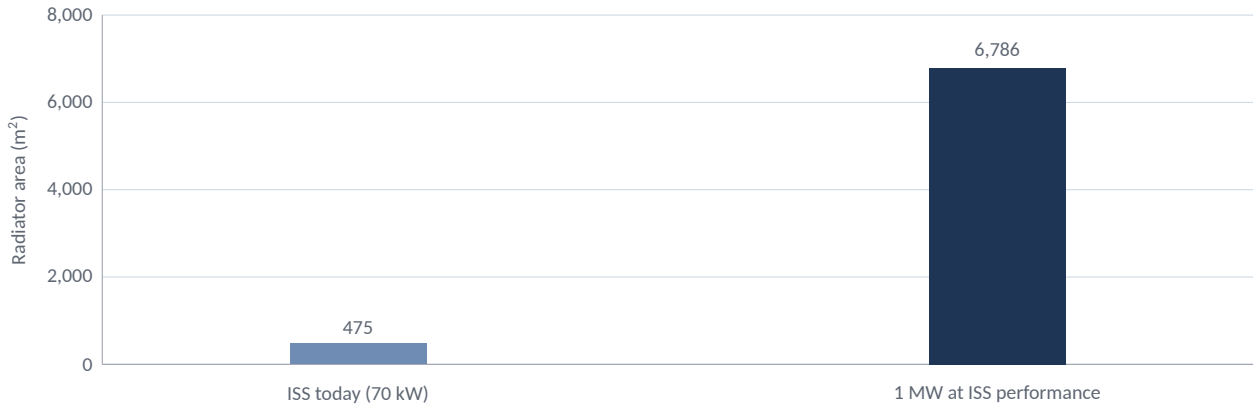
How much bigger? The main cooling system of the International Space Station (ISS) can shed at most 70 kW, using six radiators more than 23 metres long: about 475 square metres and almost 7 tonnes in total [1]. That works out at **about 7 square metres and nearly 100 kilograms of radiator for every kilowatt**.

So why isn't building bigger radiators enough? It might look like a simple question of space. It isn't, for four reasons.

- **They are expensive.** By our own estimate, with ISS technology, shedding 1 megawatt of heat would require about 6,800 square metres of radiators, nearly 100 tonnes: about 145 million dollars just to launch them at today's prices [1, 78].
- **They are heavy.** On high-power spacecraft powered by a nuclear reactor, the radiator can account for 40% or more of the mass of the entire power system [3]. And in space every kilogram counts twice: it costs money to

EXHIBIT 1

At ISS performance, rejecting 1 MW of heat would take about 6,800 m^2 of radiators



Note: 1 MW figure is a BSEIF estimate scaling the ISS ratio of about 6.8 m^2 per kW; it would weigh about 96 tonnes.
Source: NASA, ISS Active Thermal Control System overview [1]; BSEIF calculation.

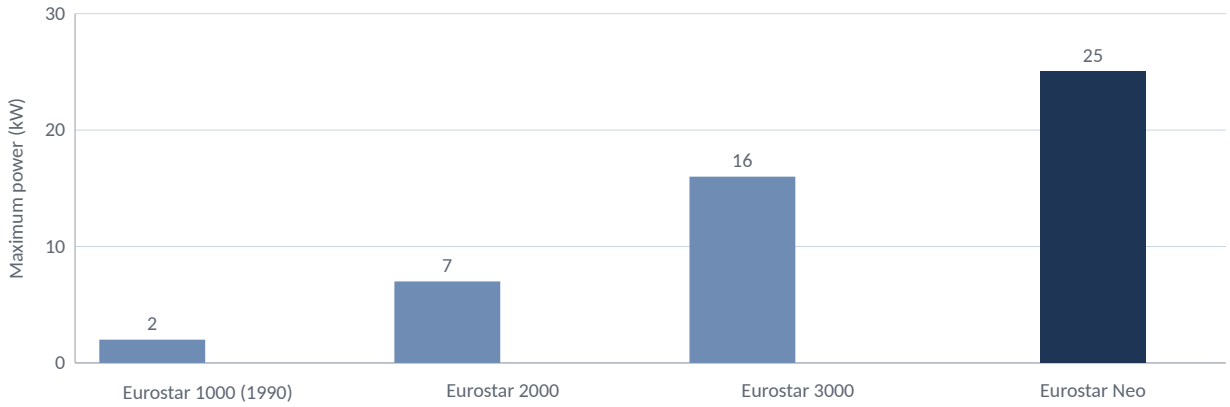
launch [4], and it takes room away from what the satellite is actually there to do, such as antennas, instruments or computers.

- **They are exposed.** The larger the surface, the more likely something is to hit it. In 2022 the Soyuz MS-22 capsule lost its coolant, and an inspection found a small hole in its radiator, possibly caused by a micrometeoroid [5].
- **They are complicated.** They have to be folded for launch, unfolded in orbit and turned so that they do not face the Sun head-on [1].

What is more, the surfaces of today's radiators already emit almost as much as is physically possible. To do better, we need to find ways of running them at higher temperatures without damaging the chips, or of building them from lighter, more conductive materials [3]. The answer, then, is **new technology, not more square metres**: we will look at it in Section 4.

EXHIBIT 2

Power per European telecom satellite has grown more than tenfold since 1990



Note: Upper end of each series' range. Earlier series show total satellite power; Eurostar Neo shows payload power only, so the chart if anything understates the growth.
Source: Flight International, 1996 [16]; ESA, Eurostar Neo overview [15].

03 Why Now: The Demand Drivers

Before turning to that technology, it is worth asking why the problem matters now, and not ten years ago. For most satellites, for decades, cooling was a minor detail: they used little power and a few panels were enough. Today it is becoming **one of the main constraints**, because we want to use more and more energy in space, both for services delivered to Earth (*space for Earth*) and for activities that stay in space (*space for space*).

3.1 Space for Earth: Services for People on the Ground

Constellations. There were 16,913 active satellites on 30 September 2026, of which 11,143 were Starlink [6], and they do more and more things that consume energy: electric thrusters, laser links, radar. Taken one by one, they are also increasingly powerful: the first telecommunications satellites in Europe's Eurostar family, launched from 1990 onwards, had at most 1–2 kW of power in total; Airbus's current Eurostar Neo devotes 25 kW to its telecommunications equipment alone, **more than ten times as much** [15, 16].

On-board computing. According to Starcloud's CEO, an imaging radar satellite generates around **10 gigabytes of data per second** [7]: processing it directly in orbit makes a lot of sense, but up there a computer heats up just as it does on our desk, with no air conditioning.

Data centres in space, the most extreme case. In November 2025 the American start-up Starcloud put the first NVIDIA H100 chip into orbit, one of the chips most widely used for artificial intelligence; for its next satellite it has announced the largest commercial deployable radiator ever sent into space, and it is aiming for a 5-gigawatt facility, **more than 70,000 times** the capacity of the ISS's main radiators [7, 8]. The giants are moving too: on 1 October 2026 the first prototype of Google's Project Suncatcher was launched, and among other things it has to test **how well the satellite can get rid of the heat produced by its chips** for artificial intelligence [9, 10]. And Europe is not standing still: the ASCEND study, funded by the European Commission and led by Thales Alenia Space (Thales and Leonardo), produced promising results on their feasibility (provided far less polluting launchers are developed) and aims for 1 gigawatt by 2050, noting that no water is needed to cool them [17]. No water, then, but plenty of radiators. If the promises are kept (we discuss this under risks), they will be the most extreme thermal

challenge in space.

3.2 Space for Space: Working in Space

Making chips in space. The British company Space Forge, by contrast, has switched on a tiny furnace in orbit that generated plasma at up to around 1,000 °C. It is the first step towards producing chip materials in orbit: without gravity, crystals form more regularly, and the chips made from them perform better [11]. But a furnace, even in space, produces heat that has to be got rid of.

Fuel stations. Future 'fuel stations' in orbit will have to keep propellants liquid below −150 °C, and doing so may require refrigerators [12]: like the one in your kitchen, every refrigerator pushes heat out.

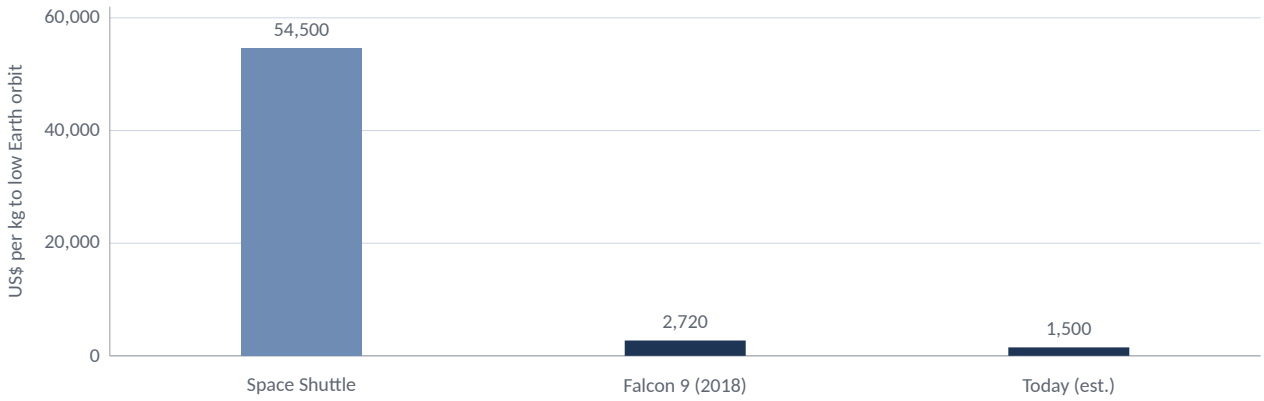
Nuclear power on the Moon. NASA wants a small nuclear reactor producing at least 100 kW of electricity, ready for launch by the end of 2029 [13]; a study carried out for NASA estimates that a plant of this size would need to shed about 300 kW of heat, **three times the electricity it produces** [14].

3.3 Why Now: Launching Costs Less

All of this is also made possible by falling launch costs: the price of putting a kilogram into low Earth orbit has dropped from about 54,500 dollars with the Space Shuttle to about 2,720 with Falcon 9 (NASA estimates published in 2018), **a twentieth of the cost** [4], and is estimated at around 1,500 dollars today [78].

EXHIBIT 3

Putting a kilogram into low Earth orbit costs a twentieth of what it did with the Shuttle



Note: Shuttle and Falcon 9 from the same 2018 NASA paper (nominal dollars); the current estimate comes from a different source and method.
Source: Jones, NASA Ames, 2018 [4]; Forethought [78].

More satellites, each more powerful, and new activities in orbit and on the Moon: demand for cooling **grows with the number of spacecraft and, at the same time, with the power of each one**. Who will build the technology to meet it? That is the value chain covered in the next section.

04 The Thermal Management Value Chain

Power in orbit is growing fast, and nearly all of it ends up as heat. SpaceX says its first orbital computing satellite will carry about 110 square metres of deployable radiators for a 120 kW payload [18]. The International Space Station needs about 475 square metres to shed 70 kW (Section 2) [1]. In space there is no air or water to carry heat away; spacecraft can only radiate it, so more power means more surface, more weight and a bigger launch bill [20]. With radiators held at about 20 °C, one megawatt of computing would need around 1,200 square metres [19]: far less than the 6,800 implied by ISS performance, but still the size of four tennis courts.

Money has followed the chips, not the cooling. Orbital data-centre start-up Starcloud has raised $450 million since 2024, $420 million of it in 2026 [41, 21], while market researchers put annual spending on spacecraft thermal control at roughly $2 billion [22, 23]. Funding rounds for thermal hardware appear to be far smaller, though reliable data are scarce.

The chain runs from materials and coatings, through components, to satellite builders such as Airbus and Thales Alenia Space. Some research aims to draw heat straight from the chip.

4.1 Segment by Segment

Radiators come first. Fixed panels are routine; deployable ones are proven on large telecoms satellites but not at computing scale [27, 39]. Weight and the risk of a stuck, unrepairable mechanism are the constraints. This is the segment most open to newcomers, although SpaceX builds its own.

Heat pipes and their longer-range cousins, loop heat pipes, are sealed tubes that move heat without moving parts. They are the most mature segment, and formal qualification standards protect incumbents such as Belgium's EHP [28–30]. Newer variants leave some room for entrants.

Materials offer a supplier role. Graphite sheets already fly, carbon-fibre panels are in development, and graphene is still at the test stage. In 2017 the Graphene Flagship, ESA, Italy's national research council (CNR) and Leonardo tested graphene-coated cooling components on weightless parabolic flights; no orbital results appear to have been published [31–33]. Italian industry also makes radiators: Thales Alenia Space, a third owned by Leonardo, supplies those for Europe's service module on NASA's Orion capsule [34].

Coatings determine how well a radiator sheds heat. Standard white paints are mature but darken in orbit under ultraviolet light, so they absorb more sunlight and the radiator itself heats up. Adaptive coatings, which change how much heat they emit as conditions change, are less mature and appear less crowded; durability and scarce flight data are the hurdles [25, 26].

In **active cooling**, pumped liquid loops have flown on large satellites; heat pumps, which raise the radiator's temperature so that, by the fourth-power law of Section 2, a smaller surface sheds the same heat, remain mostly in studies [36–38]. Moving parts must run unrepaired for years, so components such as pumps are easier for newcomers to enter than whole systems.

The funding gap is an early-stage opportunity, and the realistic route is to start with a component or material and build a flight record on a small mission before attempting a system. Maturity claims often come from manufacturers.

EXHIBIT 4

Radiators and adjustable coatings are the segments most open to start-ups

SEGMENT	MATURITY	BOTTLENECK	START-UP POTENTIAL
Radiators	High (fixed); medium (deployable at scale)	Weight, deployment reliability	High
Heat pipes and loop heat pipes	Very high	Qualification, flight heritage	Low to medium
Materials (carbon, graphite, graphene)	Medium; graphene low	Cost, scale, qualification	Medium
Coatings (standard, adjustable)	High; adjustable low to medium	Durability, little flight data	Low; adjustable high
Active systems (loops, heat pumps)	High on large satellites; heat pumps low	Moving parts, power, weight	Medium (components)

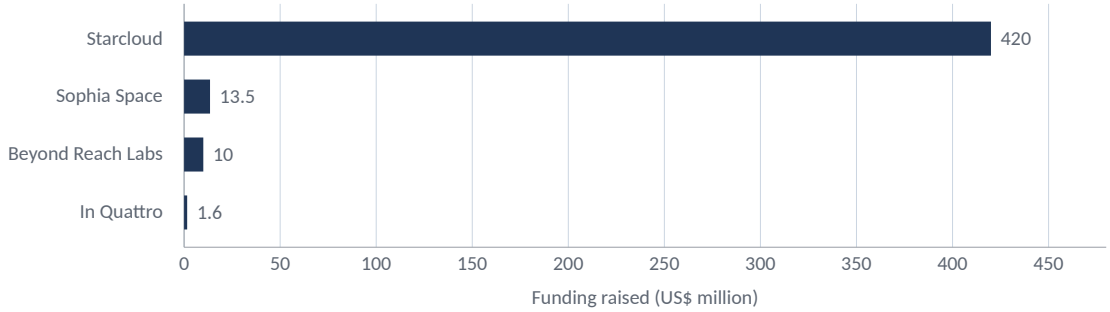
Note: BSEIF assessment based on the sources listed; maturity claims often come from manufacturers.

Source: Sources [24]–[39]; Bocconi Students Energy & Infrastructure Finance, Venture Division.

The map shows where new entrants can realistically win. Whether capital is reaching them is a separate question, and the one Section 5 answers.

EXHIBIT 5

Starcloud alone has raised about 17 times what the thermal start-ups we profile have disclosed



Note: Starcloud: Series A (March 2026) plus extension (August 2026). Sophia Space: total raised; Beyond Reach Labs: seed; In Quattro: seed of €435,000 (April 2024) plus a further €1 million from Galaxia, about $1.6 million in total. SmartIR not disclosed.

Source: TechCrunch [41]; Reuters via BNN Bloomberg [21]; Section 6 sources [52], [56], [84], [85].

05 Capital Flows

If the opportunity sits in components and materials, money should be following it there. The evidence suggests it is not. Specialised thermal technologies are critical to the space industry; instead, investment figures often focus on the larger systems they support. According to the European Space Policy Institute (ESPI), global investment in space ventures reached €11.7 billion in 2025, with €4.7 billion directed towards launch companies and €3.1 billion towards satellite manufacturing [40]. Substantial funding is also evident in orbital computing, where Starcloud raised $170 million in March 2026 and another $250 million in August to develop space-based data centres [41, 21].

Larger systems naturally require more capital than individual components, so these funding differences alone do not necessarily indicate underinvestment. Nevertheless, ESPI shows how concentrated European funding remains: the five largest European rounds in 2025 accounted for €629 million of the €1.4 billion raised, almost half of the total, while scale-up funding still lags [40]. This matters especially for specialised suppliers, as PwC identifies costly qualification requirements and limited testing capacity as major barriers even in the US space supply chain, with compliance costs that smaller suppliers struggle to absorb [42].

For thermal management, these financing challenges coincide with unresolved technological needs. NASA Johnson's 2026 Thermal Technology Roadmap identifies gaps in advanced radiators and thermal control coatings [43]. While capital flows into larger space systems, independent thermal suppliers must secure the funding to develop, test, and qualify the components that these systems depend on.

European institutional investment may create new opportunities for specialised suppliers. According to ESA, European public space budgets rose by 12% to €13.5 billion in 2025, mostly driven by increased national defence spending [44]. The EU's IRIS^2 programme, a major initiative originally valued at €10.6 billion and now estimated at €15.6 billion by consortium member Hispasat, also includes mechanisms to bring smaller suppliers alongside major satellite manufacturers [45–48]: its regulation requires the consortium to subcontract at least 30% of the contract's value to small and medium-sized enterprises outside the core group [86]. For early-stage investors, opportunities lie in financing thermal specialists that can supply multiple space projects, rather than depending on the success of a single platform.

Section 6 turns that thesis into names: the young companies we think are best placed to fill the gap.

06 Scouting: Start-Ups to Watch

This section maps the five value-chain segments of the Section 4 table (radiators; heat pipes and loop heat pipes; materials; coatings; and active systems) to the early-stage firms active in each. An initial population of 26 thermal-hardware suppliers was compiled from European Space Agency (ESA) incubation records, NASA Small Business Innovation Research (SBIR) awards, accelerator cohorts and trade press. Each firm was assessed against four inclusion criteria: (i) a seed or pre-institutional funding stage; (ii) thermal management as the core product or intellectual property; (iii) a demonstrable pathway to space application; and (iv) verifiability through public sources. Four firms met all four criteria and are profiled below; Exhibit 6, at the end of the section, summarises them in a comparable format. No qualifying firm was found in heat pipes and loop heat pipes, or in heat pumps (Section 6.5). Beyond Reach Labs is included as a reasoned exception to criterion (ii): its first product line is solar-array structures, but the company presents thermal radiators as a second application of the same deployable technology, and its letters of intent cover heat dissipation as well as power [55, 92]. For In Quattro, figures not yet public come from our interview with its CEO [85].

6.1 SmartIR (United Kingdom): Adaptive-Emissivity Coatings

SmartIR, a University of Manchester spin-out founded in 2020, develops graphene-based radiators whose infrared emissivity can be adjusted electrically [49–51]. The approach lets a spacecraft increase heat rejection in sunlight and reduce it in eclipse, without mechanical louvres or supplementary heaters. Its first orbital demonstration, on a pico-satellite launched with SpaceX's Transporter-12 mission in January 2025, was intended to raise the technology from Technology Readiness Level (TRL) 4.5 to TRL 6 [49, 50]; a second payload flew in March 2025 [51]. Its seed funding came through the Seraphim Space Camp accelerator in 2022, for an undisclosed amount [51, 88]. The firm sits in the adjustable-coatings segment, which Section 4 identifies as less crowded and high in start-up potential. Its relevance lies in power economy: heater power avoided becomes available to the payload. The principal uncertainties are the absence of published flight data and the unproven extension of the technology beyond small satellites.

6.2 Sophia Space (United States): Integrated Passive Radiators

Sophia Space, founded in Pasadena in 2023, designs modular computing "tiles" of about 1 m^2, each combining solar cells, processors and a passive radiating surface, so that every processor sheds its heat through its own panel [52–54]. The architecture turns orbital heat rejection into a question of available surface area rather than of dedicated radiator systems. The firm closed a $10 million seed round in February 2026, bringing total funding to $13.5 million, and plans to build and ground-test its first two tiles in 2026 [52, 53]. It targets on-board computing first, selling tiles to satellite operators that need to process data in orbit, and orbital data centres later, the most extreme thermal challenge identified in Section 3 [52]. An orbital demonstration of the complete tile is planned for late 2027 or early 2028 [52, 53]. The firm's objective of about 1 MW from an array of 2,000 to 2,500 tiles [53, 54] implies roughly 400–500 W per tile, the level passive cooling must sustain.

6.3 Beyond Reach Labs (United States): Deployable Radiating Structures

Beyond Reach Labs, a Y Combinator alumnus based in Brooklyn, develops rigid deployable structures that stow to about 6 m in length and deploy to 625 m^2 in their largest configuration [55]. Following a $10 million seed round announced in July 2026 [55, 56], the company reports about $350 million in letters of intent covering both power generation and heat dissipation, as well as two contracts with undisclosed customers for further evaluation [55]. The smallest model completed a first ground deployment test in August 2026 and is due to finish ground qualification by the end of 2026; no unit has yet flown [89, 90]. Its relevance follows from Section 2: shedding more heat requires larger radiators, and at kilowatt-to-megawatt scale that area exceeds what fits in a launch fairing unless it is folded. The principal uncertainties are that the company currently focuses on solar-array structures, with no dedicated radiator product yet [55], although it presents radiators as a second application of the same structures [92], and that letters of intent are not binding.

6.4 In Quattro (Italy): Two-Phase Cooling Loops

In Quattro is a spin-off of ENEA, the Italian National Agency for New Technologies, Energy and Sustainable Economic Development, and was incubated at the ESA Business Incubation Centre in Lazio from 2019 to 2022 [58, 59]. Its system cools electronics by flow boiling: the working fluid evaporates on the hot component and circulates in a closed loop, which the company states achieves higher heat-transfer coefficients than liquid cooling or heat pipes at lower flow rates and pumping power [91]. This places it in the active-systems segment of the Section 4 table. The technology was tested with ENEA during ESA's 72nd parabolic-flight campaign, the tenth flown by its founders' ENEA team with ESA, the last two with a satellite prototype [59, 85]. With E4 Computer Engineering, the firm built the first commercial prototype of a server with four Nvidia H100 GPUs and evaporative cooling, whose evaporator is designed to dissipate up to 1 kW per socket [57]. This addresses a central constraint of orbital computing: extracting kilowatt-scale heat from processors without air. In April 2024 it raised a €435,000 seed round from Galaxia, the aerospace technology-transfer programme of CDP Venture Capital and Obloo Ventures, which presented it as a developer of thermal control technology for satellites [84]; Galaxia followed with a further €1 million [85]. Outstanding milestones are a space-qualified unit, now in development in an Italian Space Agency (ASI) project, and the closing of a Series A of €4–5 million with Italian funds [85].

6.5 Segments Without a Seed-Stage Entrant

Two parts of the Section 4 table produced no qualifying firm. In heat pipes and loop heat pipes, the most mature segment, the firms identified were established suppliers, corporate subsidiaries or grant-funded small businesses rather than seed-stage start-ups, consistent with the qualification barriers that Section 4 describes. No start-up has yet emerged in heat pumps, a segment still largely at the agency-study stage. The most advanced European effort, an ESA study carried out by NLR with Celeroton and closed in 2016, produced a breadboard heat pump with a coefficient of performance of 2.6 at TRL 3 [37]. Because heat pumps raise radiator temperature and so reduce the radiator area required, the absence of commercial entrants points to room for new firms.

6.6 Discussion

None of the four firms has disclosed more than $13.5 million in funding, far below the orbital-computing rounds documented in Section 5, and three of the four have yet to demonstrate their thermal technology in orbit. This

is consistent with Section 4's observation that funding for thermal hardware appears far smaller than for the systems it serves. Three of the four also address gaps that NASA Johnson's 2026 Thermal Technology Roadmap identifies in advanced radiators and thermal control coatings (Section 5). Since all four sell to prime contractors and platform builders, the route by which this capital is recovered is addressed in Section 7.

EXHIBIT 6

Four start-ups across three segments, all at seed stage or earlier

START-UP	COUNTRY	SEGMENT (SEC. 4)	TRL	LATEST ROUND	TARGET CUSTOMER
SmartIR	UK	Coatings (adjustable); materials (graphene)	4.5, target 6 after 2025 flight (company-stated)	Seed via Seraphim Space Camp (2022); amount undisclosed	Small-satellite manufacturers and operators
Sophia Space	US	Radiators (integrated into compute tiles)	≈3–4 (est.): first tiles in ground testing, 2026	Seed, $10m (Feb 2026)	Satellite operators needing on-orbit computing; later, orbital data centres
Beyond Reach Labs	US	Radiators (deployable)	≈4 (est.): first ground deployment, Aug 2026; not yet flown	Seed, $10m (Jul 2026)	High-power constellations, orbital data centres, commercial space stations
In Quattro	Italy	Active systems (two-phase loops)	≈5–6 in space, ≈7 on the ground (est., interview)	Seed, €435k (Apr 2024), plus €1m from Galaxia; Series A in progress	Satellite thermal control; HPC servers and data centres

Note: Status as of October 2026. Only SmartIR has published a TRL, which is company-stated. Values marked "est." are BSEIF assessments against NASA's TRL definitions [87], based on the public test evidence shown. For In Quattro, data come from our interview with its CEO [85], information not available for the other companies.

Source: SmartIR [49]–[51], [88]; Sophia Space [52]–[54]; Beyond Reach Labs [55], [56], [89], [90], [92]; In Quattro [57]–[59], [84], [85], [91].

07 Exit and Valuation: How the Capital Comes Back

For a venture investor, a rising valuation only becomes a return at exit, when the fund sells its stake, usually to an industrial buyer (M&A) or on the stock market (IPO). Which route is viable depends on who is able to recognise the company's value. In the space sector, M&A clearly dominates: in a historical dataset compiled by SpaceFund, 86% of space startup exits between 2000 and 2020 took this form [60]. Buyers broadly fall into two profiles, each with its own logic.

Prime contractors sign the contract with the end customer (space agencies, operators, defence ministries), take responsibility for the complete system and source subsystems from a network of suppliers. In Europe, the main satellite primes are Airbus Defence and Space, OHB and Thales Alenia Space, a joint venture between Thales (67%) and Leonardo (33%) which, together with Telespazio, forms the two groups' Space Alliance [61]. Recent deals show primes buying established companies to strengthen their position in a segment. Lockheed Martin acquired the spacecraft manufacturer Terran Orbital in 2024 in a deal announced at an enterprise value of about $450 million, which provided for $0.25 in cash per share and the repayment of existing debt [62]. Raytheon bought the small-satellite maker Blue Canyon Technologies in December 2020, an acquisition that cost it $426 million, net of cash received [63].

Integrators and new space consolidators build subsystems or smaller platforms and grow by acquiring specialist suppliers in order to integrate vertically, which makes acquisitions part of their business model. Redwire, for example, was created in 2020 when the private equity firm AE Industrial Partners acquired and combined Deep

Space Systems and Adcole Space [64]. In thermal management, Phantom Space bought Thermal Management Technologies (TMT, 2026) to support its planned orbital data centre constellation [65], Arquimea acquired IberEspacio (2022) for €19 million, a figure that includes the assumption of debt [66], and Redwire paid about $17 million for Roccor (2020), a supplier of deployable structures and thermal products [64, 67].

EXHIBIT 7

Thermal deals so far are small; the large values sit with platforms and diversified players

DEAL	YEAR	VALUE (US$M)	EV / REVENUE
Eaton / Boyd Thermal	2026	9,500	5.6x
Lockheed Martin / Terran Orbital	2024	450	3.3x
Raytheon / Blue Canyon Technologies	2020	426	–
Arquimea / IberEspacio	2022	19 (€)	–
Redwire / Roccor	2020	17	–

Note: EV/revenue: Terran on FY2023 revenue of $135.9m; Boyd on 2026E sales of $1.7bn (22.5x 2026E adjusted EBITDA). Terran was a distressed sale, so its multiple is a floor; Boyd is a diversified group sold at the peak of data-centre demand, so its multiple is a ceiling. Boyd agreed in 2025, closed March 2026. Blank where revenue is not disclosed. IberEspacio value in euros, including assumed debt.

Source: Company announcements and filings [62]–[67], [72], [82], [83]; EV/revenue multiples: BSEIF calculation.

An IPO, by contrast, requires public markets to value the company as a standalone business, and therefore a scale that a specialised component supplier rarely reaches. Commercial market estimates, to be taken as indicative, put the market for satellite thermal control systems at around $2 billion in 2026 [22]: a niche within a space economy worth $626 billion in 2025 and expected to pass $1 trillion by 2034 [69]. The largest recent space listing involved a far broader platform: SpaceX, which began trading on Nasdaq on 12 June 2026 [70], reported consolidated 2025 revenue of $18.7 billion across its space, connectivity and AI segments [71].

The core market, however, understates what a thermal startup could address. The same know-how can serve adjacent markets, as Boyd Thermal shows: it began as an aerospace thermal supplier and now sells mainly liquid cooling for data centres [72]. Liquid cooling for terrestrial data centres is estimated to grow from $4.1 billion in 2026 to $27.7 billion by 2033 [73]. For orbital data centres, commercial forecasts for 2035 range from $8.3 billion [74] to $39 billion [75]. The orbital data centre forecasts cover the overall market, of which thermal systems would represent only a share. The TMT deal described above shows that a satellite thermal supplier can already reach orbital data centres; the terrestrial market, by contrast, requires adapting the technology to new applications.

These routes to an exit rest on assumptions that could fail. Section 8 sets out what could break the thesis.

08 Risks

Cooling in orbit is a small, technically demanding market whose growth depends on decisions made by others. Demand hinges on whether new power-hungry applications materialise, access to customers requires flight heritage that takes time to build, and the buyers are few, large and increasingly inclined to build what they need themselves.

Orbital data centres may remain hype. The most ambitious new source of cooling demand depends on a market that has yet to prove itself. SpaceX itself acknowledges this: its IPO filing warns that its orbital data centre

plans involve unproven technologies and may not achieve commercial viability [76]. BCG estimates that an orbital data centre would today carry a 2.5–3x cost premium over a terrestrial one on a 20-year total cost of ownership basis [77]. A separate model by Forethought puts cost parity at launch costs of around $100 per kilogram, a fifteen-fold reduction from today's roughly $1,500 [78]. If orbital data centres fail to materialise, cooling in orbit would lose a major growth driver and depend on demand from satellite constellations and high-power payloads alone.

Qualification cycles are long and costly. New space technologies face a "flight-proven paradox": without flight heritage they struggle to win the trust of buyers, insurers and investors, yet the only way to gain that heritage is to fly [79]. This delays revenue and increases the capital needed to get there.

Customers are few and concentrated. Satellite fleets are highly concentrated: SpaceX's Starlink accounts for roughly two-thirds of active satellites (Section 3). Fleet share is not the same as spending on thermal hardware, but the largest operator relies heavily on its own production: SpaceX designs and manufactures a significant portion of its components in-house [80]. In Europe, the proposed "Bromo" combination of Airbus, Thales and Leonardo's space businesses targets economies of scale and optimised production [81]. If completed, it would bring two of Europe's three main satellite primes under one roof, concentrating demand in fewer buyers, strengthening their bargaining power over suppliers and shrinking the pool of potential acquirers described in Section 7. OHB and Indra Space have opposed it on competition grounds, and a decision from Brussels is not expected before the second half of 2027 [68].

Primes and integrators may develop or buy the technology. Vertical integration can take two forms, with opposite effects for a startup. In-house development can reduce demand for externally supplied components, as illustrated by SpaceX's vertically integrated model [80]. Acquisition can provide an exit for the company acquired but may narrow the market for its competitors (Section 7). For a startup selling a single component, the risk is being squeezed between customers who build the technology themselves and competitors offering complete systems.

None of these risks is unique to thermal technology. Together, though, they explain why the segment remains underfunded, and why investors who judge it correctly could be rewarded.

09 Investment Thesis

Forecasts for the space economy differ mainly in what they count. Novaspace puts it at $626 billion in 2025 and above $1 trillion by 2034 (Section 7). The World Economic Forum and McKinsey, who include more of the activity that space enables on the ground, expect $1.8 trillion by 2035, with the space hardware and services "backbone" alone rising from $330 billion in 2023 to about $755 billion [93]. Almost every kilowatt added along that path ends up as heat that must be radiated away. Our thesis is that thermal management is enabling infrastructure for this growth, and that early-stage capital should target it through three principles.

Sell parts that fit many platforms, not one system. The investable layer is components with a clear interface: radiator panels and deployable structures, adaptive coatings, and the pumps, evaporators and cold plates of two-phase loops (Section 4). A part that fits many spacecraft can be sold to primes, integrators and new operators alike, so its revenue does not depend on any single constellation or orbital data centre succeeding. This matters in a market where Starlink accounts for about two-thirds of active satellites and SpaceX builds much of its hardware in-house (Section 8). It also keeps the exit open: integrators and consolidators such as Phantom Space, Redwire and Arquimea have already bought thermal specialists to integrate vertically (Section 7). Complete thermal systems are a different proposition: they put a young company in competition with its own customers and require more capital than a seed round can provide.

Position for space-for-space, where the constraint binds hardest. Services delivered to Earth (communications, observation, navigation) pay for most of today's demand, but the activities that will extend the space economy beyond them are the most heat-intensive: furnaces producing semiconductor materials, cryogenic propellant depots, commercial stations and nuclear power on the Moon, where a 100 kW reactor must shed about 300 kW of heat (Section 3.2). The in-orbit services market is still at an early stage, worth an estimated $3 billion in cumulative revenue over the next decade [94], so it cannot yet carry a start-up on its own. That is precisely why the timing matters: a supplier that builds flight heritage today on space-for-Earth missions will be the qualified option when in-space activity scales, and none of these activities can scale without the radiators, loops and coatings that remove their heat.

Use markets on the ground to de-risk, not to replace, the space case. Qualification cycles are long (Section 8), and a thermal start-up needs revenue and real-world testing while it waits for flight opportunities. Technologies that also serve terrestrial markets, above all liquid cooling for data centres, expected to grow from $4.1 billion in 2026 to $27.7 billion by 2033 (Section 7), can fund development and validate performance with demanding customers. The destination remains space; ground revenue is the bridge. Boyd Thermal shows the value of that bridge: an aerospace thermal supplier that grew into data-centre cooling and was acquired by Eaton for $9.5 billion (Section 7). Products with no use on Earth, such as very large deployable radiators, remain investable, but should be valued against the smaller space-only exits seen so far (Exhibit 7).

What would change our view. If orbital data centres stall, an important upside disappears but the thesis holds, because constellations and space-for-space activities still need to reject more heat. It weakens if primes and integrators bring thermal design in-house, or if consolidation such as the proposed Bromo combination leaves too few buyers in Europe (Section 8).

10 Conclusion

Every watt that goes into orbit comes back out as heat, and in a vacuum the only way to shed it is a radiator. On the International Space Station that costs about 7 square metres and nearly 100 kilograms of radiator for every kilowatt (Section 2). Better materials, coatings and loops can bring those figures down, but they cannot remove the physics. Whichever constellation, station or orbital data centre wins, it will need lighter, hotter-running and more reliable thermal systems.

The market has not caught up with that constraint. The thermal layer attracts a small fraction of the capital flowing into space: the four start-ups we profile have disclosed about $25 million between them, against $420 million raised by Starcloud in 2026 alone (Section 5), and all of them are still at seed stage or earlier. Few buyers, slow flight qualification and small exits so far explain why the segment is underfunded (Sections 7 and 8). They do not make it less necessary. That mismatch is the opportunity: whoever makes cooling lighter and more efficient enables the growth of power in space.

Several milestones over the next two to three years will show whether the thesis is on track: whether Starcloud's deployable radiator and Google's Project Suncatcher return usable thermal data from orbit (Section 3), whether adaptive-coating and two-phase start-ups publish flight results, whether thermal suppliers turn revenue on the ground into flight heritage, and whether the proposed Bromo combination narrows the pool of European buyers (Section 8).

Europe has the building blocks. Thales Alenia Space already supplies radiators for the European Service Module on NASA's Orion capsule, Italian research has tested graphene cooling components in weightlessness, and In Quattro has carried two-phase cooling from parabolic flights to GPU servers (Sections 4 and 6). What it lacks is the early capital to turn that know-how into flight-qualified products at the pace the market now requires.

The same constraint is not confined to orbit. Our previous report followed the nuclear fuel on which the West's relaunch of nuclear power depends; this one has followed the heat that power leaves behind in orbit. Both point to the same lesson for early-stage investors: the bottleneck is often not the headline technology, but the component layer beneath it.

***Disclaimer**: This report is published for information and education only. It is not investment advice and is not an offer or a recommendation to buy or sell any security or to invest in any company named in it. It reflects the authors' reading of public sources, and of an interview with In Quattro's chief executive, at the date of publication. Market estimates from commercial research firms have not been independently verified.*

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