AEROSPACE DELTA AGENDA 2030

ZUID-HOLLAND

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Cover image: Hubble’s view of Cassiopeia © ESA-ESTEC

Inside cover image: European Service Module-1 in flight © ESA-ESTEC

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Executive Summary

The Aerospace Delta Agenda 2030 has been constructed by InnovationQuarter in close collaboration with the industry, regional governments, national government, the knowledge institutions and all pertinent aerospace hotspot organizations in Zuid-Holland. The aerospace sector, consisting of the aviation, space and drone sectors, has long been a driving force behind economic growth and societal progress in the region. However, the sector faces significant societal, economic, and geopolitical challenges which require joint action from the industry, government and knowledge institutions. To bolster these collaborative efforts and better position the Zuid-Holland aerospace cluster in international value chains and programs, a regional identity and brand has been created, the Aerospace Delta.

These two factors form the base of the new agenda which presents a comprehensive overview of the Aerospace Delta as a regional aerospace (innovation) ecosystem consisting of over 260 organizations, 6 unique subclusters and multiple well-renowned knowledge and educational institutes. By building on the main markets and areas of expertise in Zuid-Holland, the Aerospace Delta is committed to driving collaborative efforts that contribute to the big societal challenges facing the space, aviation and drone sectors.

An analysis of the global market trends and opportunities affecting the aerospace sectors is presented. Combined with input from the regional ecosystem, a list of shared challenges and ambitions is defined that interconnect the Aerospace Delta. To act effectively on fundamental market shifts and technology transitions effectively and to realize its ambitions, 6 strategic focus themes are proposed that lay the foundation for the Aerospace Delta's integrated programs and projects. The strategic focus themes include: initiating programs targeting climate change, the development of a shared innovation and testing infrastructure, improving industrialization, enhancing the start- and scale-up ecosystem, strengthening the talent pool and facilitating (sub)clusters in (cross-sectoral/international) collaboration.

A total of 22 innovation projects have been formulated with the industry, field labs and knowledge institutions in the region, clustered into 5 integrated programs: Sustainable Aviation, Automation & Digital Technology, Advanced Composite Materials, Space-for-Earth and Aerospace Delta Cluster Development. An overview of the projects can be found on page 80. The projects are described in more detail in the Appendix.

Image: Dutch Tulip Fields (Source: ESA-ESTEC)

Introduction

In 2016, the aerospace industry in Zuid-Holland collaborated with knowledge institutions and regional governments to establish the Aero-Space Agenda Zuid-Holland, laying the foundation for a robust regional aerospace ecosystem and international connections. Over the past seven years, significant societal, economic, and geopolitical challenges and opportunities have arisen that necessitate collaborative action towards 2030 in all aerospace sectors: the aviation, space, and the drone sectors. Consequently, to initiate joint action and promote the regional aerospace cluster, the agenda required an update.

The previous agenda, initiated by regional aerospace companies and knowledge institutions, was formally presented by InnovationQuarter to the province of Zuid-Holland, which led to the integration of the aerospace industry in the province's economic and innovation policy agenda. Furthermore, it served as the foundation for the province's signing of a Memorandum of Understanding with the Clean Sky 2 Joint Undertaking, aimed at enhancing collaboration between regional and European aerospace R&D programs. A substantial number of the specific projects from the Aero-Space Agenda Zuid-Holland were successfully implemented. In quite some cases also with funding from the European Regional Development Fund (ERDF, or EFRO), the province of Zuid-Holland and municipalities like The Hague, Delft, Rotterdam and Katwijk. As a result, it bolstered the regional aerospace cluster along with the addition of value adding field labs and hotspots, increasing the regions attractiveness to both national and international companies and organizations.

Now, multiple significant transitions and challenges are transpiring in the aerospace subsectors that require joint action from the industry, government and knowledge institutions. And to bolster and better position the Zuid-Holland aerospace cluster in international value chains and programs, a regional identity and brand has been created. These two factors form the basis for the new agenda which will formulate the capabilities, plans and joint actions towards 2030 of the regions stakeholders as one collaborative and internationally focused aerospace cluster, the *Aerospace Delta*. This regional brand will help differentiate the cluster's products and services, showcase its unique strengths and capabilities, and attract new business opportunities to increase its market share and competitiveness.

To provide a comprehensive overview of the Aerospace Delta Zuid-Holland, the agenda offers an outline of the regional aerospace (innovation) ecosystem consisting of companies with specialized areas of expertise, 6 regional subclusters and multiple knowledge and educational institutes. In this new agenda, emphasis will lay on enabling the region to contribute to (global) societal challenges and seize new market opportunities, both national and international. In light of the intense ongoing global competitive environment, the transition towards an ecosystem-driven

economy, and the fundamental societal and geopolitical challenges underway, a coordinated approach involving all relevant regional aerospace stakeholders is of greater importance than ever before.

Introducing the Aerospace Delta

The Aerospace Delta is a progressively developing cluster with distinctive Unique Selling Points and a complete set of relevant actors in the space, aviation and Unmanned Aerial Vehicle (UAV) sectors. It encompasses industrial actors ranging from industrial companies in engineering and manufacturing to Original Equipment Manufacturers (OEM) and (sub)suppliers. Academic institutions include the University of Technology Delft, (specializing in technology), the Erasmus University Rotterdam (specializing in economics), and the Leiden University (specializing in law & legal matters). The regional research infrastructure comprises world renowned institutes such as ESA-ESTEC, TNO, and SRON, together with educational institutions at all levels, and incubation facilities such as YES!Delft, the Aerospace Innovation Hub, Unmanned Valley and ESA-BIC. Furthermore, the industry works closely together with the province of Zuid-Holland, municipalities and other (national) governmental organizations to help strengthen the aerospace cluster. For example, by the jointly developing dedicated field labs and hubs.

The comprehensive range of actors and industry organizations in the Aerospace Delta engage in a variety of (interconnected) activities, including the design and manufacturing of complete aeronautical and space (sub)systems, airport technology, UAV's as well as data analytics. An important next step is to better connect organizations and subclusters within the Aerospace Delta cluster on collaborative topics. This will enhance the competitiveness and attractiveness of the Zuid-Holland region as closely coopering clusters show larger economic growth. As the Aerospace Delta is situated in a relatively small but densely populated area, it facilitates easy connections and collaboration between subclusters and organizations. Furthermore, more opportunities arise in cross-sectoral collaboration with other high-tech sectors on joint challenges in areas such as precision engineering, advanced manufacturing, digital technology and cybersecurity.

This Aerospace Delta Agenda been constructed by InnovationQuarter in close collaboration with the industry, regional governments, national government, the knowledge institutions and all pertinent hotspot organizations. It presents a comprehensive overview of the regional ecosystem, its shared challenges and the strategic focus themes towards 2030 to help seize opportunities that interconnect the space, aviation and UAV sectors in Zuid-Holland. Joint action is required to address societal challenges such as combatting climate change and the aging population, boost the thriving start-up and scale-up ecosystem, facilitate valorization and the transfer of technology. Opportunities outlined in the agenda include the growing global demand for (net) zero emission aircraft and climate mitigating solutions, the increasing need for connectivity, the demand for smart automated solutions and systems integration capabilities, and the utilization of digital technology to enhance production processes and asset management. In line with the shared challenges and to capitalize on market opportunities in the forthcoming years, an extensive list of collaborative projects from partners in the Aerospace Delta is presented.

Image: Drone (Source Unmanned Valley)

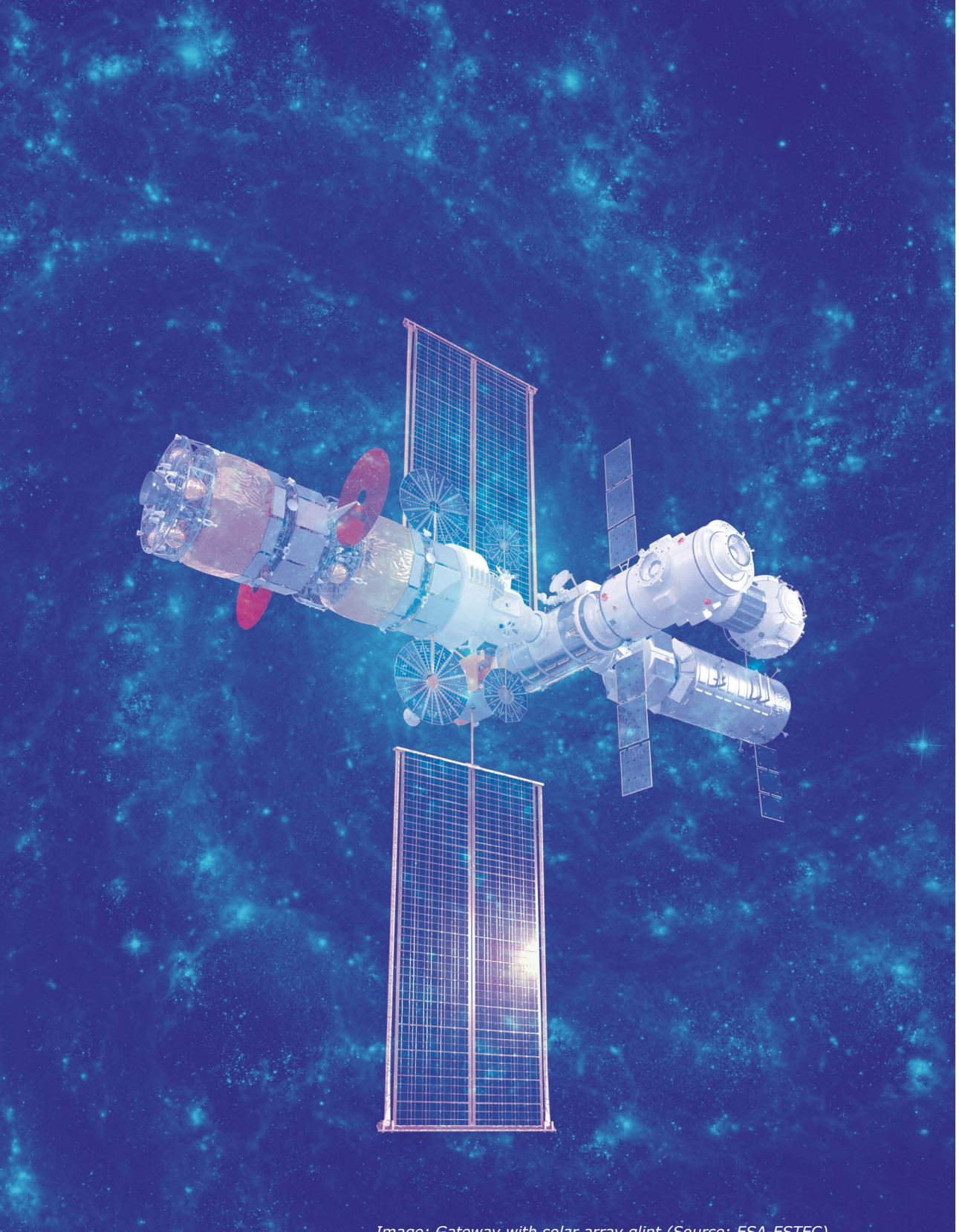


Image: Gateway with solar array glint (Source: ESA-ESTEC)

The Aerospace Delta

The aerospace ecosystem in Zuid-Holland is an internationally oriented cluster that includes the complete value chain of end-users, first- and second tier suppliers, OEM's, knowledge application and academic research. The cluster houses complete value chains in space, aeronautics and UAV's as well as in airport development and operations. This comprehensive ecosystem, called the Aerospace Delta, has differentiated itself globally on specific (niche) markets and areas of expertise.

The Aerospace Delta includes several top incubators and field labs focussing on advanced technologies such as smart and digital manufacturing, innovative downstream space applications, zero emission aviation and the development and testing of UAV platforms. Additionally, a regional airport acts as living lab and facilitates testing and demonstrations of sustainable technology and digital airport operations.

The Netherlands holds the 6th position in Europe in aerospace turnover, after France, Germany, Italy, Spain and UK. The total turnover of the aerospace sector in the Netherlands adds up to about *€4,5 billion*, highly concentrated in Zuid-Holland. Almost half of all Dutch aerospace companies, institutes and organizations are located in Zuid-Holland. More than half of the companies manufacture (parts of) aircraft and UAV's as well as satellites and satellite systems or provide solutions for airport operations. The maintenance focused hubs in the Netherlands are in very close proximity, located in Noord-Brabant and around Schiphol Airport.

The total number of aerospace companies, research and educational institutes, intermediaries and government organizations within the Aerospace Delta adds up to *260 stakeholders*. These organizations offer *9.000 jobs* as direct employment in aerospace in Zuid-Holland. When indirect jobs are considered from the different supply chains and service providers, the aerospace sector contributes to another 12.500-15.000 jobs. In total, this is about 20% of the total employment in the high-tech industry in Zuid-Holland.

Although the numbers mentioned in the Aero-space Agenda of 2016 are not entirely comparable, there has been significant growth in the number of aerospace companies (23%) and jobs (19%). This growth has been mainly due to the increase in the number of start-up companies, especially in the drone sector (application/service providers) and the space sector (up- and downstream). The aviation sector, including aeronautics and airport technology and services, has experienced a decrease in the number of companies but a

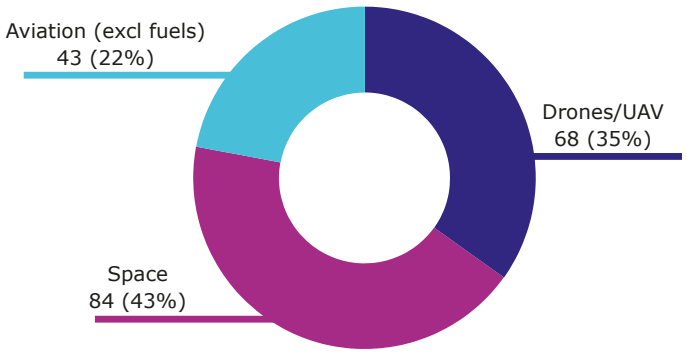


Figure 1: Private aerospace companies in Zuid-Holland

slight growth in employment. However, there is an expectation for growth in aviation-related activities driven by opportunities in sustainable aviation. (see figure 1)

Taking a closer look at the different segments, the following picture emerges. (see Table 1) Employment in the space sector is dominated by *ESA-ESTEC*, accounting for around 50% of the total jobs in that segment. The average number of employees per company is relatively low, with 21 jobs per company in the space sector, corroborated by the relatively large amount of start-up and small sized companies with less than 10 people on their payroll. In contrast, the aviation sector has an average of 68 people per company, with over half of the employment at *GKN-Fokker* and the rest of the private sector averaging around 30 FTE's per company. In the drone sector, the average number of jobs at private companies is even smaller with approximately 5 FTE's. This reflects the maturity level of the sector which is still in development with many small start-up companies.

Table 1 The Aerospace Delta Ecosystem in Zuid-Holland

Aerospace Delta	Private Companies	Institutes & Government Organizations	Employment
Space	84	33	4921
Aviation (incl. fuels)	43	14	3210 (3960, incl. fuels)
Drones/UAV	68	19	419
Total	**195**	**66**	**8550 (8700, incl. fuels)**

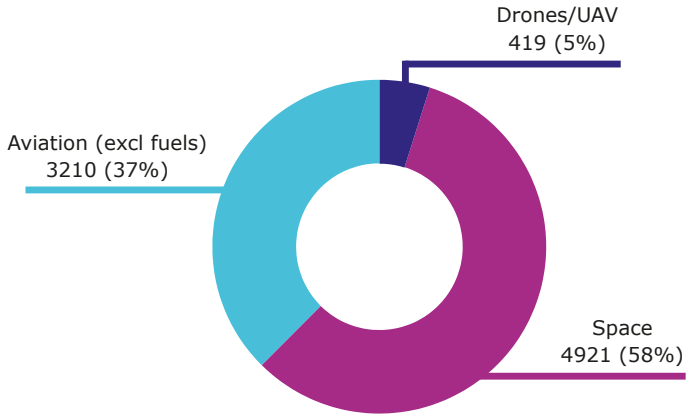


Figure 2: Overview of the labour market in the Aerospace Delta Ecosystem (FTE's)

Education & Knowledge Infrastructure

The Aerospace Delta region has an extensive academic and applied research infrastructure where technology, business and law in the aerospace knowledge fields are well represented. The 3 research universities provide academic education to more than 100,000 students and 4,000 PhD-candidates. This scientific environment keeps the region in a top position with respect to innovative developments and the number of start-ups. There are 6 universities of applied sciences and colleges with more than 95,000 students offering programs geared towards the practical labour market. All universities of applied sciences have bachelor and/or master courses in electronics, mechatronics, (embedded)software engineering, data analytics, Artificial Intelligence and Machine Learning.

1 **The Faculty of Aerospace Engineering at the Delft University of Technology (TU Delft)** is one of the world's largest faculties devoted entirely to aerospace engineering. It is the only research and education institute in the Netherlands that is directly related to the aerospace sector. It covers the whole spectrum of aerospace engineering subjects and explores related fields such as wind energy, in close cooperation with other faculties like Electrical Engineering, Mathematics and Computer Science, Mechanical, Maritime and Materials Engineering and Applied Sciences.

2 **Leiden University** carries out very diverse research at the Faculty of Science, ranging from mathematics, computer science, astronomy, physics, chemistry and bio-pharmaceutical science to biology and environmental sciences. The Leiden Observatory is the oldest university observatory in operation today (since 1633). The International Institute of Air and Space Law at Leiden Faculty of Law, is one of the leading international academic research and teaching institutes in the world, specializing in legal and policy issues regarding aviation and space.

3 **Rotterdam School of Management, Erasmus University**, is ranked among Europe's top-tier business schools, providing research and education in which Aerospace Economics is one of its focus areas.

4 **The Leiden-Delft-Erasmus (LDE)** alliance between the three universities work closely together with the NL Space Campus in the LDE Space for Science and Society Program.

5 **Inholland University of Applied Sciences** offers the Aeronautical Engineering bachelor's degree program which educates in the broader field of the aviation and space industries. The focus of this four-year program is on designing and constructing aircraft, aircraft components, and space (sub)systems.

6 **The Leiden Instrument Makers School (LiS)** is a post-secondary college for precision engineering, with around 300 students trained in materials and glass processing, optics, and mechatronics. LiS Engineering works on both scientific and industrial assignments and can produce small batches and prototypes using their precision tools and machinery for the aero-space industry.

7 **Albeda College Rotterdam The Hague Airport College** is a dedicated aviation vocational college located at the regional airport where 450 student are trained to work in airport services related jobs.

Aerospace Research Institutes

The region of Zuid-Holland has a very high density of researchers connected to the many academic and private research institutes. The institutes at the University of Technology Delft, TNO, SRON and of course ESA-ESTEC – the technological heart of the European Space Agency with around 2.800 researchers- are all top ranked institutes and attract many international researchers, students, and companies.

1 **TU Delft Faculty of Aerospace Engineering** research facilities; the research programs and facilities are further explained on the next page.

2 **Robotics Institute (TU Delft)**; unites all the university's research in the field of robotics. Its main challenge is to get robots and humans to work together effectively in unstructured environments, and real settings.

3 **ESA-ESTEC European Space Research and Technology Centre** in Noordwijk; the technological heart of the European Space Agency; the incubator of the European space effort where most ESA projects start and are guided through the various phases of development.

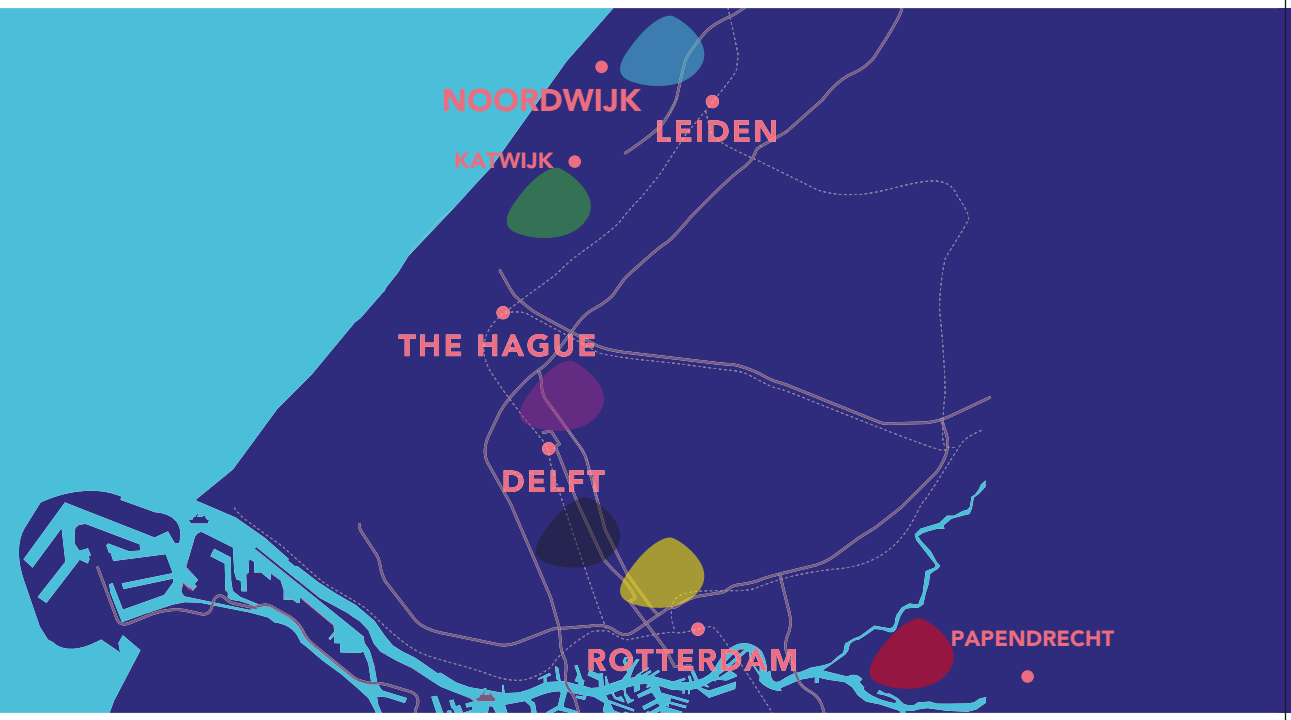
4 **TNO Space&Science Instruments** in Delft has specific capabilities: TNO has unique expertise in manufacturing high-precision optical components, so called high-end optics manufacturing. TNO manufactures customer-specific components – mirrors and lenses – that are integrated into innovative and compact systems, leading to new products such as space instruments.

5 **Delft Space Institute (TU Delft)**; combines the strengths of different faculties of TU Delft to enable and cutting-edge research in the space domain. The focus is on Sensing from Space, Distributed Space Systems and Space Robotics.

6 **SRON Netherlands Institute for Space Research in Leiden**; it is the Dutch national expertise institute for scientific space research. Since the foundation of the institute by university groups they have provided key contributions to instruments of missions of the major space agencies, ESA, NASA, and JAXA. As a national expertise institute, SRON stimulates collaboration between the science community, technological institutes, and industry.

7 **The Leiden University Observatory**; carries out world-class astronomy research and develops key technologies for astronomical discoveries.

8 **SAM|XL** stands for Smart Advanced Manufacturing XL; SAM|XL is a collaborative research center at TU Delft Campus. They develop, demonstrate and de-risk smart manufacturing solutions. SAM|XL focuses on automated production processes of large-size, lightweight/ composite structures for the high-tech aerospace sector.



The Aerospace Innovation Ecosystem

The Aerospace Delta region has 6 hotspot locations where companies (large, SME's and start-ups) can work together, often with research and knowledge institutes, on research & development (R&D) projects. Most locations have dedicated (shared) facilities, specifically customized for aerospace related R&D, in addition to offices and workspaces. In some cases, community managers are appointed to enhance both internal and external relations. For example, by hosting regular content-driven networking events. In addition, programs are offered to support technology development, roadmaps to commercialization, entrepreneurship and access to finance.

Innovation ecosystem of campuses, hotspots and field labs in the Aerospace Delta

- **TU Delft 'Aerospace' Campus**
- **NL Space Campus**
- **Unmanned Valley Valkenburg**
- **Technology Park Ypenburg**
- **Rotterdam The Hague (Innovation) Airport**
- **GKN Aerospace Multi Technology Center**

In many instances, new initiatives or projects extend beyond a single hotspot or field lab. For instance, Unmanned Valley and NL Space Campus converge in their use of sensor-based data from drones and satellites. At Technology Park Ypenburg, aircraft engineers collaborate with Rotterdam The Hague (Innovation) Airport to facilitate the development of electric and hydrogen-powered flight in the Netherlands. Launcher structure designers at NL Space Campus partner with the manufacturing industry at Technology Park Ypenburg to create a new lightweight concept which can then be cured in the largest autoclave in the Netherlands at GKN Multi Technology Center in Papendrecht. In the Aerospace Innovation Hub on the Delft Aerospace Campus, start-up teams from TU Delft can grow their businesses through the incubator of ESA-BIC at the NL Space Campus. And the drone technology developers of the MAVlab at the TU Delft Aerospace Campus utilize UMV's testing capabilities. These are just a few examples of the numerous collaborations between various field labs and subclusters within the aerospace ecosystem of Zuid-Holland. And collaborations are not limited to subclusters in Zuid-Holland or exclusively within the aerospace ecosystem. There is national and international cooperation, as well as a growing collaboration with the high-tech industry in the region. The Aerospace Delta aims to strengthen these collaborations in the near future by developing dedicated programs for both cross-sectoral and national collaboration.

In this section, the 6 regional hotspots are presented in more detail with an outline of their areas of expertise, services, facilities and ambitions for the (near) future. The agenda proceeds with the ‘Main Markets & Areas of Expertise in the Aerospace Delta’ on page 39.

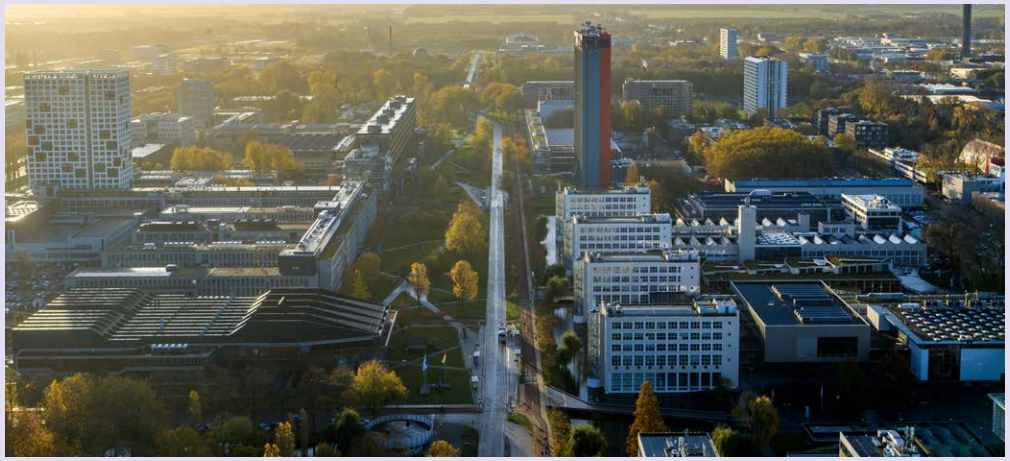


Image: TU Delft Campus (Source: TU Delft)

TU Delft Aerospace Campus

TU Delft Campus is powered by a worldwide top tech university, a high density of field labs and a strong entrepreneurial spirit proven by the various startup communities spanning over 200 companies. TU Delft Campus is the international breeding ground for radical innovations, shaping the future of Robotics, AI, Quantum, MedTech, Energy Transition and of course of Sustainable Aerospace. The TU Delft Faculty of Aerospace Engineering is ranked 1st in Europe and 8th worldwide. The 8 faculties of TU Delft offer 16 bachelors and more than 30 master programmes. The TU Delft has more than 28,000 students and 11,500 employees who share a fascination for science, design, and technology. Besides TU Delft, University of Applied Science Inholland, the Hague University of Applied Sciences, the National Research Institute TNO Space & Scientific Instrumentation and the Space Institute are also present on the campus.

TU Delft is actively engaged in various aerospace topics related to aviation, space and drones. The university’s aviation research is carried out across seven faculties, with Aerospace Engineering being the largest and most centralizing department. The research themes include hydrogen-powered aircraft, enhancing aircraft efficiency using sustainable lightweight materials, improved aerodynamics, digitalization, and the development of revolutionary new aircraft designs like the Flying V. Furthermore, the research also encompasses aspects of the aircraft in its environment, such as passenger experience, noise and emissions impact, interior design, and airport surroundings.

In addition to aviation research, TU Delft collaborates with five faculties to advance space topics. The TU Delft Space Institute focuses on several themes, including space access, monitoring from space through instrumentation and data handling, and modeling and monitoring of climate impact. Regarding drones and UAV’s, the Control and Simulation Section of the Faculty of Aerospace Engineering specializes in autonomous flight of micro to nano air vehicles, collision avoidance and swarming. Beyond core aerospace activities, TU Delft also undertakes research into enabling technologies such as Quantum, AI, robotics, and new fuel systems.

Research Facilities

1. The Aircraft Hangar with static and mechanical test facilities.
2. The Aerospace Structures and Materials Laboratory carries out ground breaking research on manufacturing, testing and inspection techniques on new materials.
3. The Micro Arial Vehicle Lab (MAVLab): leading research on miniaturization of UAV structures, autonomous operation and swarming.
4. Wind tunnel, propulsion and aerospace design lab: leading research on aerodynamics, an aircraft power and propulsion lab and design tools.
5. Flight Simulation lab: the Simona Research Simulator, that can realistically simulate all types of aircraft, helicopters and even cars.
6. The Scaled Flight Lab, where the scale model of the Flying V was built.
7. Space Cleanroom; enables assembly, integration and testing of small satellites, including propulsion test stands.
8. The Cessna Citation research aircraft at Rotterdam The Hague Airport.
9. ESP lab (Electrical Sustainable Power lab).

Moreover, TU Delft has a robust online education program. As part of the commitment to promoting sustainable aviation practices, it offers a Massive Open Online Course (MOOC) titled “Sustainable Aviation: The Route to Climate-Neutral Aviation.”

Aerospace Innovation Hub

The Aerospace Innovation Hub (AIH) at TU Delft is a vibrant community that comprises aerospace-related startups, academics, students, corporates, and industry professionals. The mission is to foster content-driven innovation in the aerospace sector by facilitating the early entrepreneurial journey, offering access to a vast aerospace network, and providing a rich aerospace talent pool. By creating an active community, the Aerospace Innovation Hub empowers their members to develop their ideas into viable and scalable products.

Members include for example OEM’s like Airbus and Embraer. Furthermore, there are some quickly growing startups moving into scale-up phase, like Qlayers and Dawn Aerospace. With the startup voucher program AIH has a yearly influx of 5 to 10 startups that start their endeavor. The success rate of the startups during the last 5 years has been around 80%.

The AIH community room and offices are located on the top four floors of the Aerospace Engineering Faculty at Delft University of Technology, which enables their members to connect closely with the faculty’s students, researchers, and facilities. AIH’s location is a dynamic and inspiring environment full of like-minded individuals who challenge and elevate each other’s work.

In addition to supporting the faculty’s Start Up Voucher program by offering entry into the community and coaching sessions with industry professionals, the AIH is committed to supporting innovations in space technology, solutions for enabling the long-term sustainability of aviation, and novel drone technology. The strength lies in connecting innovators from both inside and outside of the aerospace industry and academia, fostering collaboration and encouraging the development of groundbreaking innovations.

SAM|XL

SAM|XL stands for Smart Advanced Manufacturing XL. It is the Smart Robotics and Manufacturing Automation expertise center

that forms a unique liaison between TU Delft faculties, the industry and suppliers with the focus on large structures, components and parts. The specialization is in flexible manufacturing of low-volume, high-variation products and assemblies at industrial-scale. SAM|XL develops software and hardware to enhance the intelligence, connectivity and flexibility of industrial robots for this purpose. Automation of low-volume, high-variation and high value parts and products are very relevant in industries, such as aviation, space and also maritime. SAM|XL's vision is the widespread use of Smart Robotics Technology in the non-certified, and ultimately, in the certified domain of these industries, aimed at increasing sustainability and competitiveness. Its mission is the development of technology and talent for manufacturing automation in general, and for Smart Robotics more specifically, through industrial-scale demonstration, multi-level education and multi-disciplinary collaboration across all TRL's.

For these industries, robot technology is developed for executing complex and varied tasks on large structures that is validated and demonstrated in our industrial-scale automation lab. As a research and education center, SAM|XL does not develop and commercialize complete robotic end solutions but assists in implementation via commercial integrators or self-implementation by end-users. To facilitate the latter, SAM|XL encourages partners to be onsite for the duration of the project to intensify collaboration and maximize knowledge transfer. SAM|XL also provides hands-on training for students and staff from our industry and research partners, to uplift their digital skills in executing automation projects.

TNO Space & Scientific Instrumentation
Ever since its foundation, TNO has been active in the field of advanced optical instruments, and for over 50 years has been developing instruments for use in space, astronomy, scientific research and manufacturing industry. Examples of this work include the development of instruments for measuring the ozone layer (GOME and TROPOMI) and a space telescope (GAIA). The measuring instruments contribute to dealing with important social issues, spur on science and form the basis for industry and job opportunities in the Netherlands. TNO has a long legacy in developing instruments that monitor our planet's atmosphere and allow us to mitigate the harmful impact of greenhouse gases and air pollution. In addition to this, TNO works on systems that monitor land and water and the calibration of a wider range of optical satellite instruments. For Laser Satellite Communication, TNO builds the optical part through which the satellites communicate with ground stations and optical terminals for inter-satellite communication. It is also developing the key technologies needed for the future, more advanced terminals. Some examples are high-precision mechanisms, optical components, the production of mirrors, and components for photonics. An important task for TNO is to make the components smaller, cheaper, and, therefore, more commercially interesting.

Aeronautical & Precision Engineering Inholland University of Applied Sciences
Inholland offers Aeronautical & Precision Engineering since 1936 and aims for graduates to become directly internationally employable in the broad spectrum of aerospace industry and related sectors. To intensify collaboration with the aerospace cluster in Zuid-Holland the faculty (originally known as Vliegtuigbouwkunde HTS Haarlem) expanded to Delft in 2004. With a total of approximately 700 students, the bachelor program focuses its educational program around Structures, Performance, Manufacturing and Smart Systems and recently rolled out a new minor for Space Systems Engineering.

Thanks to its in-house laboratories the curriculum relies on a range of technology capabilities allowing education and industry to perform applied research activities. These

Image: Inholland Aeronautical & Precision Engineering (Source: Inholland)

facilities involve a fully equipped composites laboratory including an autoclave and industrial robot cell, an electric powertrain test cell, a compact low-speed wind tunnel, a lunar surface test-bed, a gas turbine- and a Mixed Reality full motion flight simulator. These facilities have enabled Inholland to develop new concepts such as demand driven education where industry can provide R&D assignments to students based on the latest innovations.

In 2019 a strategic learning-by-doing project was initiated with Dutch technology partners involving the development of an electric aircraft retrofit which is currently being prepared for first electric flight. For the coming years, the goal is to support and increase the learning community for sustainable aviation and plans are being made for follow-up projects where education, research institutes and industry can work together on decarbonization of the aviation sector.

Since the addition of Inholland to the TU Delft Campus, there is more opportunity to collaborate and experiment with innovative technologies for the aerospace sector.

Image: NL Space Campus ©-ESA-ESTEC

NL Space Campus; Connecting the Curious

NL Space Campus is the regional ecosystem where space is clustered in Zuid-Holland. It connects the curious in a community that encompasses the existing space industry, startups, students, young professionals, the research community and the Leiden, Delft and Erasmus Universities.

NL Space Campus, located in Noordwijk, between the cities of Amsterdam, The Hague and Leiden, forms the beating heart of the Dutch space ecosystem. The campus is built around ESA's European technical heart, the European Space Research and Technology Centre (ESTEC), EUSPA's Galileo Reference Centre (GRC), SBIC Noordwijk that hosts the ESA Business Incubation Centre program for startups, the visitor and educational centre Space Expo and a multitude of space-related organisations and companies.

A vibrant ecosystem

Whether active in space for decades or new in the industry, working on upstream technologies or downstream applications, in ESA-financed projects or with a commercial space business model, the NL Space Campus ecosystem offers the network, knowledge, capabilities and facilities to strengthen and accelerate space companies and maximise their positive impact on society. The Region Deal 'ESTEC and Space Campus Noordwijk' of September 2018 between the national government, the province of Zuid-Holland and the municipality of Noordwijk has been the start for transforming the Space Business Park to NL Space Campus and modernising the ESTEC site. A campus organization (NL Space Campus foundation) has been put in place and is an active player in the Dutch space ecosystem and facilities like the Field lab SCN AVATAR and the platform Groundstation Dotspace were realized. New facilities like Fablab (including a small antenna test facility) will emerge in 2023. The physical development of the campus will be a phased one, with the open-air meeting space and Fablab in the first phase (before end of 2023), followed by the Basecamp development in the next phase. On the ESTEC site the International Meeting Facility is built and will be realized before the end of 2024.

Programs to Accelerate Innovation

NL Space Campus stimulates, facilitates, and connects the ecosystem through a combination of community programming and campus facilities. It does this by:

- Regular and one-off events that form the heartbeat of the community.
- Theme-specific activities based on our roles in the ecosystem, e.g.:
  - ◇ Technology venture and transfer activities in the role as ESA Technology Broker Netherlands that we share with SBIC.
  - ◇ Programmes to facilitate the entrepreneurial journey for students in the role as consortium coordinator for One Space Hub, the implementation of RVO's One Single Hub program.
  - ◇ Cross-sectoral activities and events to ease the transfer of knowledge and capacities from space to other sectors and the other way around.
- Campus facilities that strengthen the ecosystem

Table2 Some of the members of the ecosystem available for collaboration or joint innovation

Space Agency	Netherlands Space Office
Space research and technology	ESA ESTEC; Galileo Reference Centre; SRON; GNSS Centre of Excellence; TNO; NLR
Knowledge Institutes (academic, applied and vocational)	Leiden-Delft-Erasmus University Rotterdam / RSM; Radboud Radiolab; University of Twente; Inholland University of Applied Science; LiS – Leidse Instrumentmakers School
Space industry	70+ companies in the region, including trade association SpaceNed
Valorisation, Incubation and Acceleration	ESA BIC @ SBIC Noordwijk; PLNT! (Leiden); Groundstation DotSpace

Facilities
The campus is built around ESA ESTEC, the biggest research & technology centre of the European Space Agency in Noordwijk which offers the campus community the opportunity to mobilize the knowledge, expertise, capabilities and physical facilities of ESTEC. Around ESTEC, many services, facilities and field labs are available to support the development of up- and downstream space technology & data organisations and innovations.

ESA ESTEC provides world-class facilities for vibration (mechanical and acoustic) testing, thermal cycling, -shock and -vacuum cycling, electromagnetic compatibility and interference testing, weight and centre of gravity measurement, propulsion/thruster testing, clean rooms and a solar simulator.

Incubator ESA-BIC Noordwijk offers technical, business and financial support to startups that create business models based on space technology or data. The 2-year programme is managed by Space Business Innovation Centre Noordwijk (SBIC). Incubatees get up to 80 hours of technical support, up to €50,000 incentive funding for product development and patents, business development support and advice, access to the international ESA Commercialisation Gateway community and SBIC alumni network.

Field lab SCN AVATAR: a VR/AR development centre focused on improving space engineering processes and data visualization using immersive technologies. The open innovation workplace is a collaboration between industrial and institutional parties. Co-founding partners are TU Delft, NLR, RHEA and ATG Europe.

Groundstation dotspace: DotSpace supports potential end-users of satellite applications by leveraging its network to make experience and expertise available. The foundation creates awareness in value creation of new satellite applications. DotSpace provides feedback based on fieldwork to policymakers regarding innovation and valorisation of Earth observation technology.

GNSS Centre of Excellence, a cooperation between CGI Netherlands, S&T and NLR which helps users, government and industry to raise awareness on GNSS usage and improve the resilience of GNSS-based applications.

Facilities in Development
Campus main building Basecamp and surrounding open-air meeting space that will offer multi-tenant office space, MAIT (Manufacturing, Assembly, Integration, Test)-facilities for startups and scale-ups, co-work and meeting space and catering facilities.

- Fablab: Prototype and experimentation space, providing a broad array of technical equipment, shaker, antenna test facility and office and meeting spaces.
- Philab: R&D teams working on high-impact projects will be supported with knowledge, facilities and funds for cash expenditures to accelerate the go-to-market of their innovation.
- International Meeting Facility: can host many ecosystem meetings of all sizes in parallel.
- Students are welcome for education and projects in the LDE facility that will house the to-be-developed ThesisLab and LDE Space Master.

Image: Unmanned Valley, Valkenburg Zuid-Holland (Source: Unmanned Valley)

Unmanned Valley

Unmanned Valley (UMV) is the biggest economic cluster for UAV technology in the Netherlands. It is a dedicated location for companies and organizations operating in the sensor-based industry that want to develop their innovations. The testing and housing facilities provide unique opportunities to develop UAV technology, all while benefiting from expert resources and a growing community. The 4,5-acre dedicated Unmanned Valley area is located at the former Valkenburg (ZH) naval air base, close to major cities such as Amsterdam, Rotterdam and The Hague. Since 2020, Unmanned Valley has welcomed 21 companies and organizations to the premises, providing almost 200 jobs and opportunities for 45 students. With 2000 flight operations a year and weekly events it has a lively ecosystem.

A fast-growing ecosystem
A broad range of stakeholders are involved in the community of Unmanned Valley, ranging from government bodies to research institutes and private companies. The TU Delft and the municipality of Katwijk founded Unmanned Valley in close collaboration with the province of Zuid-Holland and the National Real Estate Agency. Some private companies that found their way to Unmanned Valley in the last three years are: Atmos, Drone Flight Academy, Aerialtronics, Marshall, Mapture, NUNC Capital, Battery Labs, Fusion Engineering, Dutch Drone Academy, IL&T Aerosensing, Oceans of Energy, Avy, Drovevolt, Droonstra, Softworx, High-Eye, Nova Sky, Railconnected, AirHub, ANWB Medical Drone Service and Robin Radar. Further involvement and cooperation with regional organizations like Greenport Duin & Bollenstreek, Holland

Rijnland, NL Space Campus and municipality of Rotterdam. Additionally, ROC van Amsterdam has established a permanent classroom and workshop on the premises. A vocational school that offers classes on drone manufacturing, engineering and piloting.

Facilities
Unmanned Valley offers testing facilities 24/7, both indoor and outdoor. Unlike other testing facilities for drones in the country, Unmanned Valley has its own Air Traffic Zone (ATZ), thus no interference from other aircraft. In these outdoor test facilities simultaneous flights are allowed and make this flight box an interesting Urban Air Space (UAS) testcase where airspace needs to be shared, controlled and operated. A BVLOS corridor, drone radars and a state-of-the-art command center to the sea make long distance flights possible. Unmanned Valley offers a modern working, learning and meeting environment that is tailored to the needs of the target group. The location provides space for high-quality activity in a future-proof manner.

Drone center Unmanned Valley Valkenburg
Which type of communication technology is best for an application depends on the amount of data, the energy consumption and the frequency with which data is sent. Various networks are therefore available at Unmanned Valley, both commercial (4G, 5G) and experimental (5G with commercially still not available frequencies).

Supporting programs
Unmanned Valley initiates research projects with a strong innovative character. Knowledge development and transfer is paramount, as well as the connection between training, research and knowledge institutions, companies and authorities. At Unmanned Valley, governments, corporations, knowledge institutes, relevant on-site companies and students work together on different challenges. To validate new business opportunities or the social acceptance of UAV and sensor-based technology, for example.

As the facilitator, Unmanned Valley has the experience to set up these collaborations and has an unmatched network within the sector and a lot of industry know-how. Additionally, it offers vouchers for innovative projects and business development.

Unmanned Valley's ambitions for the near future
Unmanned Valley's ambition is to become the European Center for drone innovation. Currently, it is working hard to expand our facilities with a hydrogen refueling point, drone acoustic systems and more office space to host more start-ups and corporate programs. Soon it is the ambition to create:

- An incubator program for startups and scale-ups.
- Relevant test facilities for the agriculture sector (glasshouse testing).
- Test facilities for drone stations, drone boxes and drone ports.
- Data security and privacy awareness programs are to be offered to all companies and organizations located on site.
- Counter drone expertise and relevant test facilities around detect and protect technology

Image: Technology Park Ypenburg (Source: VOFE Ypenburg)

Technology park Ypenburg

Technology Park Ypenburg (TPY) is a high-tech business park focused on businesses in sustainable aviation, space technology, MedTech, semicon and light weight composite and plastic materials. The community members focus on developing innovative solutions in the field of high-tech manufacturing. The park offers an open community that thrives to connect with the best of the best. Through collaboration and co-creation, innovative solutions have been developed in the TPY community.

The Technology Park is located in the old Fokker Aircraft Factories in The Hague. After the aircraft company pulled out, there was a lot of high-end production space available for starting companies that could use the left behind equipment. The 50.000 m2 facility was taken over bit by bit by companies like Airborne Composites, KVE Composites, GTM Advanced Structures, Promolding and for a while Aeroworks. Other high-tech companies are Hittech Group, Exasun, Robin Radar, Conscious Aerospace, Unified International and Brookx.

Programs and facilities
To build the community and connect with other ecosystems, TPY has its own facilitating organization. It offers the following programs and activities.

Academy: For tech students, TPY is the place to grab the opportunity to enhance their ability and increase their career possibilities. Alongside gaining multiple or single company experience from the TPY companies. TPY wants to encourage the development of talent no

matter the stage of education or career. TPY student programs vary from thesis writing and internships to training and summer school. Companies have the need to attract new talent and grow current talent. TPY companies benefit from the knowledge and talent of interns and graduated engineers, active in all contemporary fields of composites research.

HAPSS: TPY is home of the Hydrogen Aircraft Powertrain and Storage System (HAPSS) project that is part of the Luchtvaart in Transitie (LiT) National Growth Fund program. The HAPSS project combines the knowledge, expertise and technology of 17 companies within the Netherlands (of which more then half is located in Zuid-Holland) with the goal to retrofit a modified zero-emission aircraft using liquid hydrogen propulsion.

Soft Landing: TPY offers a solution to help you set up your business in the Netherlands and our soft landing program to access the Netherlands and European markets. We'll introduce partners to key stakeholders and connect you with experts in setting up legal entities. TPY helps to connect with innovative peers from the high-tech manufacturing industry, including lightweight composites, plastics- and metal materials, assemblies design and production, mechatronics, and automation solutions. TPY also has an extensive network in the aviation, space- and medical markets.

Co-creation: Co-creation is a big pillar within the TPY Ecosystem. TPY facilitates in various dimensions, to make sure the members have everything they need to improve and achieve common goals. TPY drives events which are educational in content or challenging through events like "Hackathons" and "Makethons". In addition, innovation projects are set up for products and processes and help find the appropriate local, regional, national and European funding initiatives to help accelerate development. TPY's open community thrives to connect with the best of the best. The community members focus on developing innovative solutions in the field of high-tech manufacturing through collaboration.

Machine portal: Technology Park Ypenburg and its members offer a wide range of machinery and facilities to help you build your prototypes, products or testing. These machines can be rented and booked through a machine portal. Cost includes use of the machine, operators and/or programming staff, and if applicable materials. After filling out an inquiry, you will receive a fitting quotation. Most of the machines and facilities are focused on composites and high-tech manufacturing and include an automation & digitalization lab, large autoclaves, CNC milling machines and various testing equipment. All facilities are easily reachable and available for high-tech manufacturing at TPY.

Future ambitions

TPY is a key part of the vision for the City of The Hague 2030 where the expectation is to add new purpose-built and sustainable facilities to attract high-tech manufacturing companies to locate at TPY. Companies will be able to utilize dedicated facilities in our Scale Up and Innovation Center in 2024/5 as well as be active members of the community. The TPY facilitating organization will emphasize on the development of large innovation and business development projects to attract more stakeholders to become part of the community and to make cross-sectoral connections with other regional and national ecosystems.

The New Scale-up and Innovation Center will be a place for manufacturing companies that grow out of their start-up phase and want to set up their first manufacturing process. The center will offer small to medium size real production space, clean room ready spaces and small office spaces for engineers. The center will also host a small prototyping center and the TPY business center with flex offices and meeting facilities and community center.

Zuid-Holland houses the main Dutch propositions for sustainable aviation both electric and hydrogen-based initiatives between industry and the educational institutions. To make the transition of new technologies we need to increase the Dutch capability in systems integration knowledge, testing/certification and Maintenance, Repair and Overhaul (MRO). A new capability at TPY will be a Zero Emissions Integrated Systems Test Facility for Aviation. Conscious Aerospace is located at TPY, with their HAPSS program making progress under the LiT program working with OEMs such as De Havilland of Canada, Embraer of Brazil and NAC Aircraft of The Netherlands testing these new systems and technologies is an important issue.

Another important capability is the availability of a battery test lab. A lab where prototypes of battery systems for electric aviation (and other high-power applications) can be tested and further developed. The test facility will have different testing equipment and an environment for Thermal Runaway (Blow up) testing in a secured thermal combustion chamber.

Image: Rotterdam-The Hague Airport Campagne © Samantha-Bosdijk-Photography

Rotterdam The Hague (Innovation) Airport

Rotterdam The Hague Airport (RTHA) is a small regional airport within the Rotterdam-The Hague region with around 2 million passengers annually. The airport aims to be one of the first zero emission airports in the world and has therefore set up an innovation program together with the municipality of Rotterdam. This program is run by a network of companies, governmental organizations and knowledge institutes: Rotterdam The Hague Innovation Airport (RHIA). The network of partners is facilitated by an independent foundation with the same name.

The main goals of the RHIA-program are: Stimulating aviation innovations; Accelerating the energy transition; And increasing the socio-economic value of the airport. RHIA facilitates partners with the initiation of new innovative projects that correspond with the main goals of the RHIA-program. In close cooperation with the airport operational organization, it is possible to perform various research and demonstration projects within the existing safety regulations and open time slots. To determine its strategic focus, governance and financial structure, RHIA is currently undergoing a stratetic reassessment.

A cross-sectoral community

RHIA consists of a tightknit community of partners that represent various industries and organizations. The partners work closely with the aviation and airport industry, the petrochemical industry related to the Port of Rotterdam, various knowledge institutes specialized in aerospace, governmental organizations from national to regional level and many educational institutions. Community partners are e.g. the municipality of Rotterdam, TU Delft, the National Aerospace Laboratory (NLR), Shell, Transavia, Port of Rotterdam, SkyNRG, and a lot of SME's working in collaboration with the airport in different projects.

Programs and Facilities

RHIA offers various possibilities to join and/or start innovation projects. RHIA can help to setup (international) collaborations, contribute to attracting necessary funding, and support in project development. The RHIA community works on multiple projects within focus areas: sustainable, zero-emission airport and digitization of airport operations, hydrogen and electrification of flight operations and human capital.

The RHIA-community makes use of facilities on and around the airport RTHA such as testing and demonstrating facilities at the airport, including hangar space and personnel; housing facilities, like the Regus offices at the airport; conference and meeting facilities, like local gastronomy and Fletcher Hotels; various networking events happening at the airport or at partner facilities.

Specific RHIA programs and facilities at RTHA are:

Airport Technology Lab: The Airport Technology Lab (ATL) is a development, testing and demonstration environment for innovative products and services for airports. The digitization of everything that happens at airports and the application of Artificial Intelligence is increasing exponentially and making applications at the airport more important. An open Operational Data Base of the airport processes is available at RTHA. This allows (new) partners to test new digital or physical products in a simulated environment.

DutcH2 Aviation Hub: In the DutcH2 Aviation Hub partners develop operations for usage of hydrogen at airports to facilitate (demonstration) flights to European destinations. Activities in the program include production, distribution, storage, and dispensing of hydrogen for aviation, leading towards decarbonizing the whole airport ecosystem.

Field Lab Next Aviation (FNA): Under the Field Lab Next Aviation program, various projects are being carried out, all of which aim to make the airport and flight operations more sustainable. For example, projects focus on the development of airport infrastructure and procedures for flying electric and hydrogen aircraft in the future. The first projects have been started to prepare the airport for handling aircraft with new energy carriers. In the next phase there are possibilities for new parties that like to operationally test hydrogen powered and battery-electric aircraft at the airport.

Linked to the FNA is Hangar 3 at RTHA, which is the home base of the Cessna Citation II "PH-LAB". The PH-LAB is a test aircraft and a flexible facility for advanced aviation research of TU Delft and NLR . Thanks to the installed instrumentation, and modifications to the aircraft, several classes of project are possible with this flying laboratory.

Ambitions for the future

In the coming years, the RHIA partners have the following ambitions:

- Further develop demonstration facilities at air- and landside at RTHA
- Build electric and hydrogen infrastructure (storage and dispensing) at both land and airside.
- Facilitate test flights and operational experiments on gas and liquid hydrogen.
- Creation of a campus environment where companies, governments and students meet and innovate.
- Grow from innovation to implementation: further develop facilities (including hydrogen infrastructure) to provide sustainable, commercial flights.
- Strengthen collaboration among RHIA partners and attract new organizations.

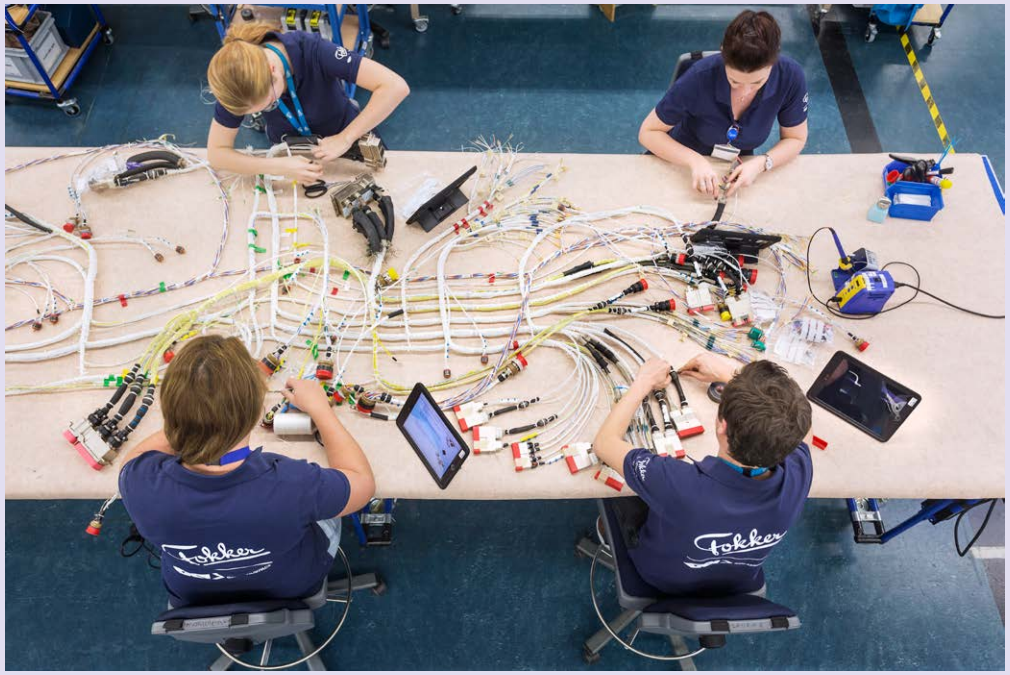


Image: GKN Fokker Factory Papendrecht (Source: GKN Fokker)

GKN Multi Technology Center

GKN Fokker in Papendrecht is part of one of the world's largest suppliers to the international aviation industry, GKN Aerospace. GKN Aerospace makes components and systems for almost all the world's major aircraft manufacturers, and its technology is present on 90% of modern aircraft. In 2015, GKN Aerospace acquired and integrated Fokker Technologies with its rich aviation history and leading technologies. GKN Fokker has around 3,400 employees in the Netherlands.

Tails and wing parts of aircraft have been made in Papendrecht for decades. The site is currently being substantially expanded by moving the production of cabling and landing gear from Brabant to the Drechtsteden. By the end of 2023, all production in the field of aircraft wiring systems, landing gear and work on aircraft tails and wing parts will be brought together in Papendrecht on a thriving multi-technology campus capable of employing more than 1,800 people. There will also be a brand-new training center on the site. A total of 80 million will be invested by GKN Aerospace in the Netherlands. 500 new employees are also being hired in the near term.

Main partners
Almost all traditional aircraft manufacturers are customers of GKN Fokker, and smaller start-ups and scale-ups involved in electric flying and advanced air mobility are also part of GKN Fokker's portfolio. Furthermore, there is a lot of cooperation within the Dutch ecosystem in the field of R&D. These include TU Delft, NLR, Inholland, Da Vinci College Dordrecht, Eindhoven University of Technology and University of Twente. GKN Fokker's technology in the field of electrification and lightweight composites plays an important role in making aviation more sustainable. GKN also work closely with companies such as KVE, Toray, Airborne, ParaPy, Maat transport.

Main facilities (accessible for research projects)
The Papendrecht location has various facilities required to achieve its goals. For example, it has an extensive bathing line for treating surfaces. The bathing line is fully REACH-compliant and certified. In addition, the site contains several large autoclaves, which are suitable for cooperation projects.

Partner programs (how to work with GKN Fokker)
GKN Fokker is involved in several important projects and programs in both the Netherlands and the EU. This is always done in close cooperation with partners, both nationally and internationally. In this way, GKN Fokker is connected to the wider Dutch ecosystem and the European value chain. Currently, GKN Fokker is leading two key sub-projects, namely the use of thermoplastics for structural components and the development of advanced high-power cabling systems for electric flying, funded from the growth fund under the Aviation in Transition consortium. In Papendrecht, specific work is being done to develop next-generation wiring or Electric Wiring and Interconnection Systems (EWIS), which will act as an 'enabler' for electric flying and hydrogen-based propulsion.

Within the Luchtvaart in Transitie (LiT) consortium, the company works with parties such as Boeing and Embraer to best demonstrate and connect Dutch knowledge and expertise. In the European context, GKN Fokker focuses on the development of lightweight structural parts and participates in various European projects and programs, such as Clean Aviation and Horizon Europe.

Image: GKN Fokker Empennages © GKN Fokker

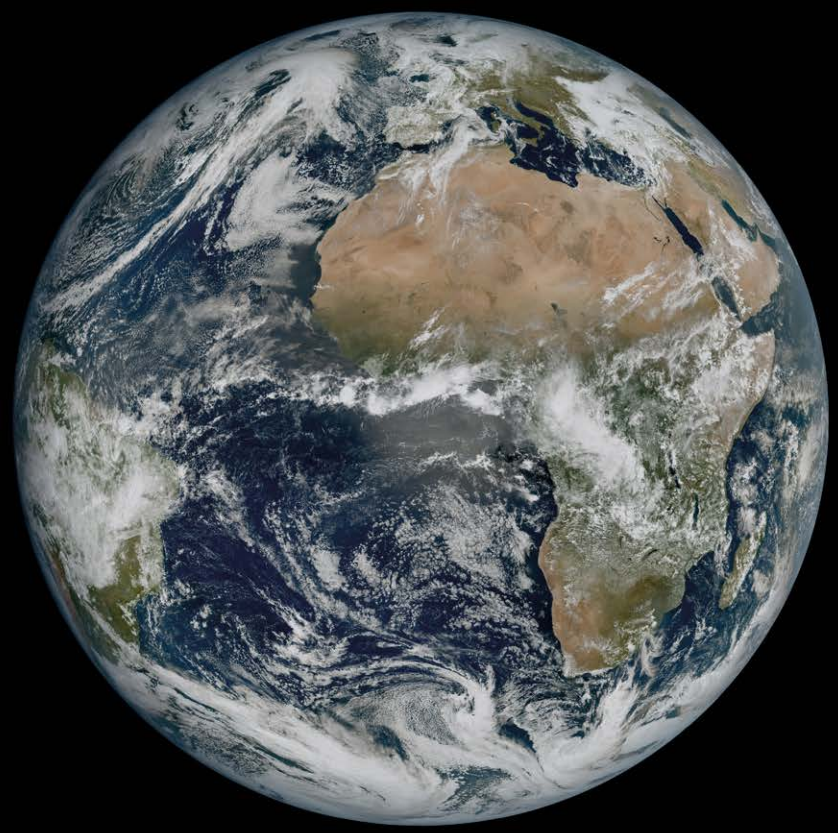


Image: Full Earth Disc © ESA-ESTEC

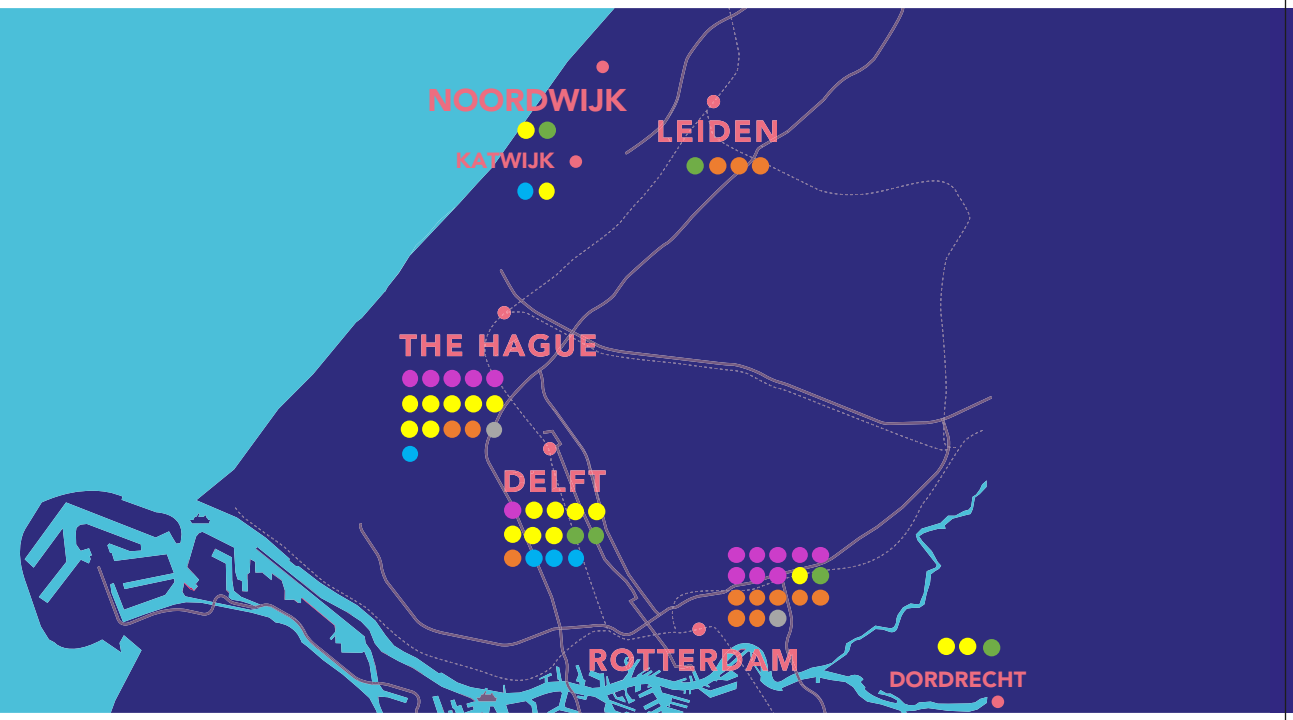
Main markets and Areas of Expertise

The Aerospace Delta has emerged as a thriving cluster for the aerospace industry, boasting a rich history of innovation and expertise in aviation, space and drones. Companies and key stakeholders in the region have built and developed its expertise in specific main (niche) markets and areas of specialization. From cutting-edge space technology to advanced manufacturing capabilities, we uncover the diverse and unique range of activities and technologies that differentiate the region’s aerospace ecosystem in the global aerospace sector.

Upstream Space & Instrumentation
The upstream space market mainly involves the development of infrastructure in space to communicate, navigate and monitor processes on Earth and in the atmosphere with advanced instruments on board satellites. Despite the Dutch government’s limited space budget, the Netherlands, and therefore also our region, is still among the world’s best in several areas thanks to prior investments. The region has two strong well-renowned technology institutes: SRON Netherlands Institute for Space Research and TNO Space and Scientific Instrumentation have internationally recognized qualities in the field of optics, extremely precise instruments, sensors, and temperature control of satellites. This has led to a strong specialization and competitive advantage of the regional industry in these areas and target several growing markets such as satellite communication, space-for-earth and Remote Sensing which will be discussed later. In terms of size, Dutch space companies are mostly SMEs in the Netherlands (sometimes with a large parent company) and provide essential products and services for the global space market.

Small Satellites & Systems
The regional industry consisting of large companies (i.e. Airbus NL, VDL and Demcon), SMEs (i.e. GTM, ISISpace, ATG Europe and Airborne) and many startups (i.e. Dawn Aerospace, T-Minus Engineering and Revolv Space) have specialized in a number of services, products and subsystems for satellites and launchers. Examples are the solar panels that provide the energy supply on almost every ESA satellite, small satellites and components for control and propulsion. In addition, the region supplies products to European launchers and thus plays a key role in independent access to space. However, the lack of a dedicated national policy for space makes it more difficult for the industry to stay competitive in relation to other EU countries, especially regarding ESA projects.

The Commercial Space Market
In the Aerospace Delta region, more businesses are moving to commercial customers also known as the New Space Economy. Whether it concerns solar panels, propulsion systems, positioning systems, bus structures or



Aerospace Delta Zuid-Holland Aeronautics & Aviation Cluster

- **Airport Technology, Infrastructure & Fuels**
- **Airport Manufacturing & Systems**
- **Knowledge Institutions, Education & Training**
- **Aircraft Maintenance & Service Providers**
- **Government & Facilitating Services**
- **Airport & Aerospace Hotspots**

For a total overview of the ecosystem visit: www.aerospacedelta.nl

complete integrated CubeSats, everything is supplied to the vastly growing commercial market. And although this market is still in its early stages of development, the outlook and foreseen competition for the regional space industry are promising but fierce. The latest space technology that is being developed by the industry in the region is laser satellite communication (Laser SatCom) which will have a major impact on our competitive position. This technology will be discussed later in the chapter Market Opportunities in Space.

Downstream Services & Climate Monitoring

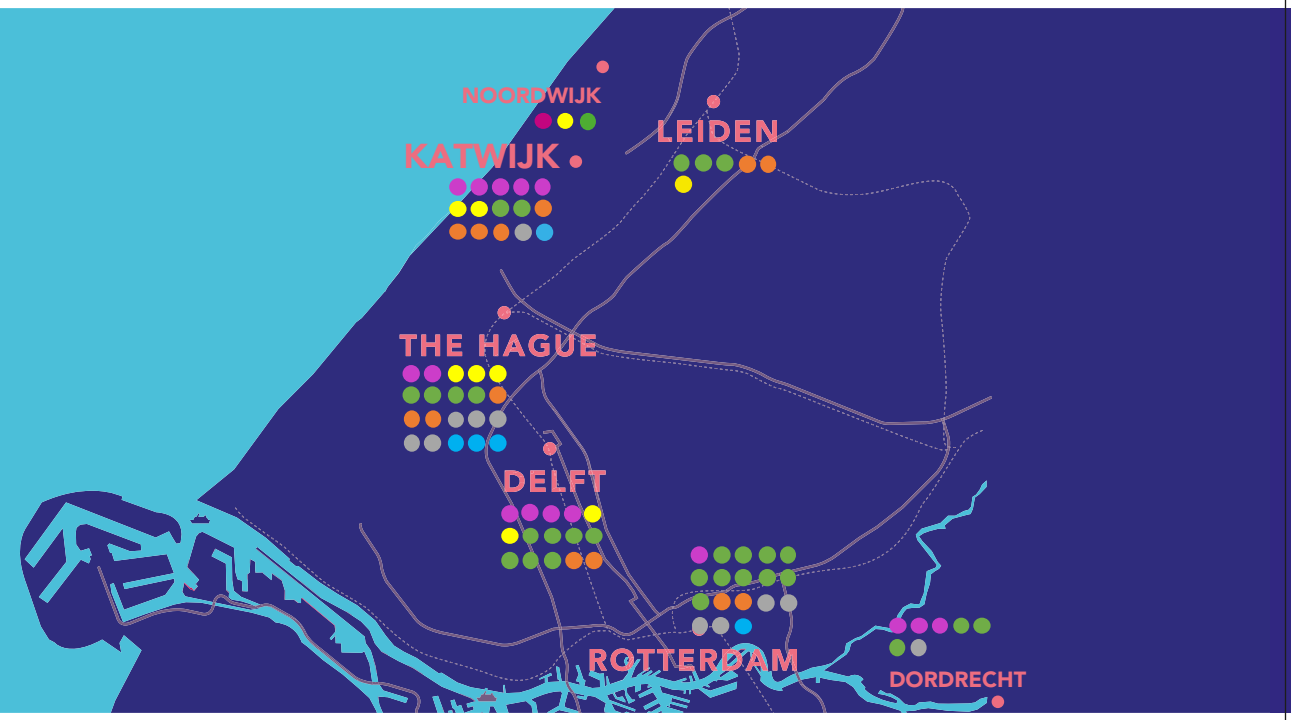
The Netherlands has a growing and thriving sector that is becoming stronger in the application of space services for users on Earth (the space-for-earth economy), in the field of Earth Observation (EO), navigation and communication. A growing number of companies in the region such as Sensar, Space4Good, Orbital Eye and CGI are focusing on interpreting Earth observation data, partly with the use of Artificial Intelligence (AI). Applications include mapping subsidence of infrastructure (dikes, bridges), availability of fresh water, detection of changes, for example in land use or illegal earthmoving and deforestation. For example, Dutch water management knowledge is renowned worldwide. This knowledge, partly based on satellite data, is available to take policy measures and also leads to economic activity.

But the Netherlands is probably best known for its atmospheric research in climate monitoring based on satellite data with its own developed scientific instruments. Both the Netherlands and the Aerospace Delta region is investing quite heavily in technology development and implementation of small satellites in this relatively new market of Climate Research and Emission Monitoring.

Sustainable Aviation

Aviation will have to make its contribution to preventing global warming by limiting and ultimately excluding harmful emissions such as CO_2, NO_x and soot particles. By applying its expertise in a number of distinctive areas, partners in the region are actively working on a more sustainable aviation sector. An important field of expertise is aerodynamics to minimize air resistance and improve efficiencies, thus emissions. Also, minimizing the required energy to fly an aircraft will be crucial for new clean energy carriers as they contain less energy density per kg compared to conventional kerosene or can be more expensive. The development by TU Delft of the aircraft concept Flying-V is the most extreme example of minimizing air resistance to optimize aerodynamics. This aircraft could offer a saving of 20% on (sustainable) fuel consumption. With the aerodynamic knowledge of TU Delft, its spin-off startups and knowledge diffusion to regional companies, necessary short-term improvements are also developed.

In Zuid-Holland, a growing group of companies and knowledge institutes have specialized in the development of sustainable aircraft propulsion technology. These parties have expertise in hydrogen combustion, hydrogen-electric and full-electric flight. The regional parties mainly focus on the technology of battery packaging in aircraft, where weight, ignition hazard, and thermal management are critical factors. Additionally, hydrogen-powered aviation requires significant advancements in technology, which are being supported through funding from the Luchtvaart in Transitie National Growth Fund (i.e. the HAPSS and HOT projects). The objective of this program is to convert a turboprop aircraft for around 40 passengers, utilizing a liquid hydrogen fuel cell and electric motor powertrain with a range of approximately 750 kilometers. The fuel cell technology has already been developed locally for the maritime sector, while the electric motor was developed by a Dutch automotive company. The storage of liquid hydrogen at cryogenic temperatures (-253 degrees Celsius) relies on expertise in materials, cryogenic technology, sensors, and management systems, which is available from experiences in the process industry. Close collaboration is underway with Rotterdam The Hague Airport to prepare for handling hydrogen-powered



aircraft, and RTHA/Schiphol is working with national and international partners on European projects to build knowledge and gain access to the necessary infrastructure, procedures, and permits in a step-by-step manner. One of which is the DutcH2 Aviation Hub project that will be described later in the agenda.

Expertise in Reducing Noise Pollution

The aviation industry also needs to reduce noise pollution around airports. While electric motors can significantly reduce aircraft noise, air resistance and propellers still generate noise at higher speeds. To address this, the Smart Rotors project was initiated to develop knowledge on reducing noise from propellers on electric aircraft and rotor blades on larger drones and eVTOLs (electric Vertical Takeoff and Landing platforms), also known as flying taxis. The work of NLR and TU Delft in this field is closely monitored internationally, as it has the potential to greatly impact the usability of eVTOLs in urban areas, electric aircraft in general as well as spin-off to larger propellor aircraft.

Sustainable Aviation Fuels

Currently, for long-haul commercial aviation, kerosene remains the only viable option. However, in the port of Rotterdam, fuel producers are actively working to develop more sustainable alternatives. The main alternative, Sustainable Aviation Fuel (SAF), focuses on producing biokerosene from waste oils such as frying oil. Another initiative, named Zenid, aims to create completely CO_2-neutral circular kerosene using a combination of green hydrogen, water, and CO_2 captured from the air. Although the technology is currently at a lab scale, the next step is to build a pilot plant in the port of Rotterdam to demonstrate its scalability.

Flying Robots & Innovative Air Mobility

Innovative Air Mobility encompasses a range of aircraft, including drones, small flying robots, and larger eVTOLs. The drone sector has experienced exceptional growth, increasing by 350% since the initial cluster survey in 2016. This growth is fueled by key factors such as the Micro Air Vehicle Lab (MAVLab)

Aerospace Delta Zuid-Holland Drones Cluster

- **UAV/AAM Systems & Components**
- **Software & Technology**
- **Inspection, Surveillance & Mapping**
- **Research, Testing & Education**
- **End Users**
- **Others**

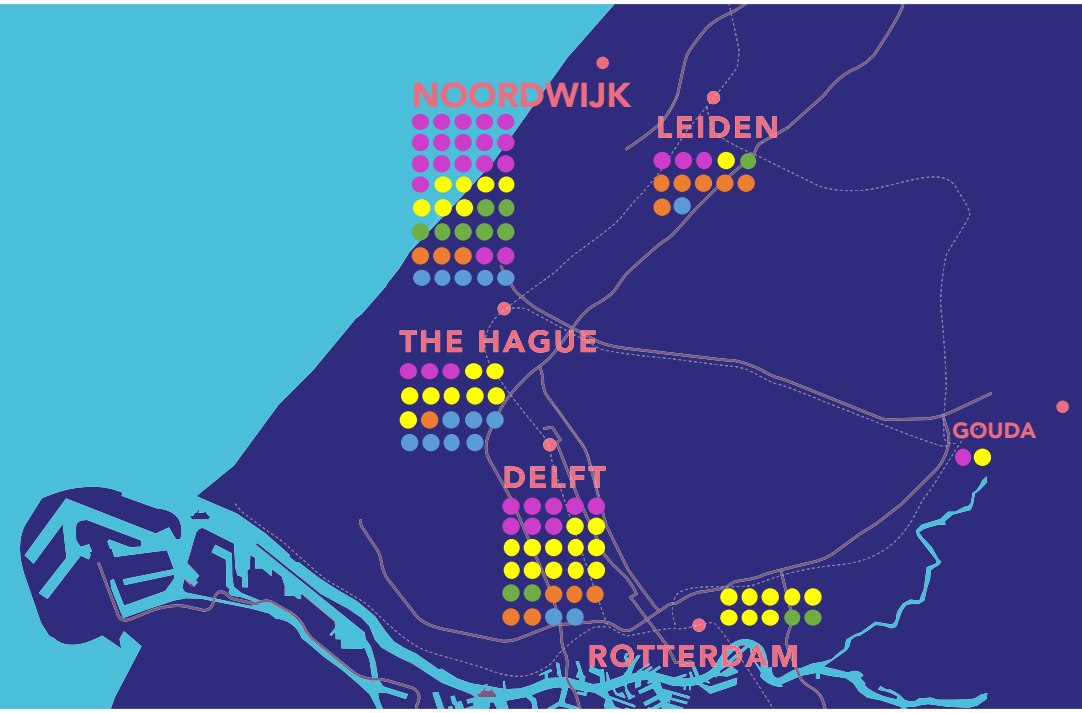
For a total overview of the ecosystem visit: www.aerospacedelta.nl

of TU Delft, which has spawned startups seeking to commercialize their technologies; Unmanned Valley, where regional companies conduct initial platform tests; and the Port of Rotterdam, which actively promotes the application potential of drones in the port and offshore industry. Drones also find niche markets in "indoor" applications like glasshouse horticulture, storage facilities, and first responder services such as fire brigades and police departments, as well as critical deliveries to hospitals.

The Zuid-Holland region is a key player in the development of drones for for surveillance and inspection services, especially for assets in the Port of Rotterdam and offshore wind farms. Companies are focused on developing precise inspection technology that can operate in challenging conditions. Offshore asset inspections require drones to perform extended and complex missions. Furthermore, companies are increasingly focusing on specific aspects of the technology, such as control software, 5G connectivity, and AI-based data processing.

Autonomous Systems & U-Space

Currently, most drones are operated by human pilots, but the industry is rapidly moving towards autonomous drone flight, especially for monitoring and security tasks. Many companies in the region are focusing their technology on this market. Autonomy is easier to achieve for indoor operations compared to outdoor operations where airspace is shared with other users. However, autonomous flying has the potential to greatly enhance productivity. Beyond-Visual-Line-of-Sight (BVLOS) capability also plays a crucial role in the sector's growth. Unmanned Valley has operational BVLOS corridors to the sea for flights. However, the Netherlands lags behind neigbouring countries in implementing European rules for air traffic control systems for drones (U-Space), which hinders the development of the drone sector in the region. Essential prerequisites include airspace layout, U-Space, digital infrastructure, and regulations for testing and implementation, which need to be rolled out nationwide in accordance with EU regulations as soon as possible. The province of Zuid-Holland is



actively working on these issues to support the sector's impact and growth, including on the regulatory requirements for use cases in larger drones and eVTOLs.

The implementation of U-Space is crucial to accommodate emerging forms of air mobility, such as cargo drones and flying taxis, within and between urban areas. While no companies in the region currently specialize in developing these Advanced Air Mobility systems, several firms supply components and subsystems to foreign OEM's, including rotor blades, composite structural components, and electrical systems. As neighboring countries make rapid progress in this field, the province of Zuid-Holland expects to receive the first applications for constructing vertiports, which are landing and takeoff locations for cargo and air taxis in the near future. This highlights the importance of regional collaboration.

Aerospace Grade Composites

The Zuid-Holland region has been a pioneer in developing innovative lightweight materials, especially composites, bonded hybrid components and structures. Mainly driven by the aviation industry's demand for lighter constructions in aircraft parts such as fuselage, wings, tails, and interiors. The TU Delft Faculty of Aerospace Engineering has been a leader in composites and lightweight constructions, resulting in the emergence of several composite spin-off companies in the region focused on aviation. Composites also play a crucial role in space, such as in solar panels. Regional stakeholders are actively involved in manufacturing composite launcher parts using innovative constructions and qualification methods, recognizing the importance of weight reduction in saving fuel, costs, and potentially mitigating climate emissions. Composites have become indispensable not only in aerospace but also in other sectors like maritime, offshore, automotive, and mechanical engineering.

The development of composite materials and their processing techniques is continuously advancing, and parties are actively seeking automation solutions due to the labour-intensive nature of composite manufacturing. The region has established significant expertise in this area, including the research lab SAM|XL by TU Delft, as well as the Inholland Composites Lab and private companies conducting applied research for automation in composite manufacturing. The focus on recyclability and circularity is also growing, with extensive research on the use of thermoplastics for primary constructions.

Furthermore, the region is actively exploring the application of biobased composites using materials such as bamboo or flax fibers with biological resins. Although still in its early stages for high-quality aviation applications, the available knowledge in the region suggests that we can expect significant developments in this area.

Aerospace Delta Zuid-Holland Space Cluster

- **Upstream: Satellite Manufacturing**
- **Downstream: Satellite Services**
- **Launch & Ground Equipment**
- **Knowledge Institutions, Education & Training**
- **Government & Facilitating Services**

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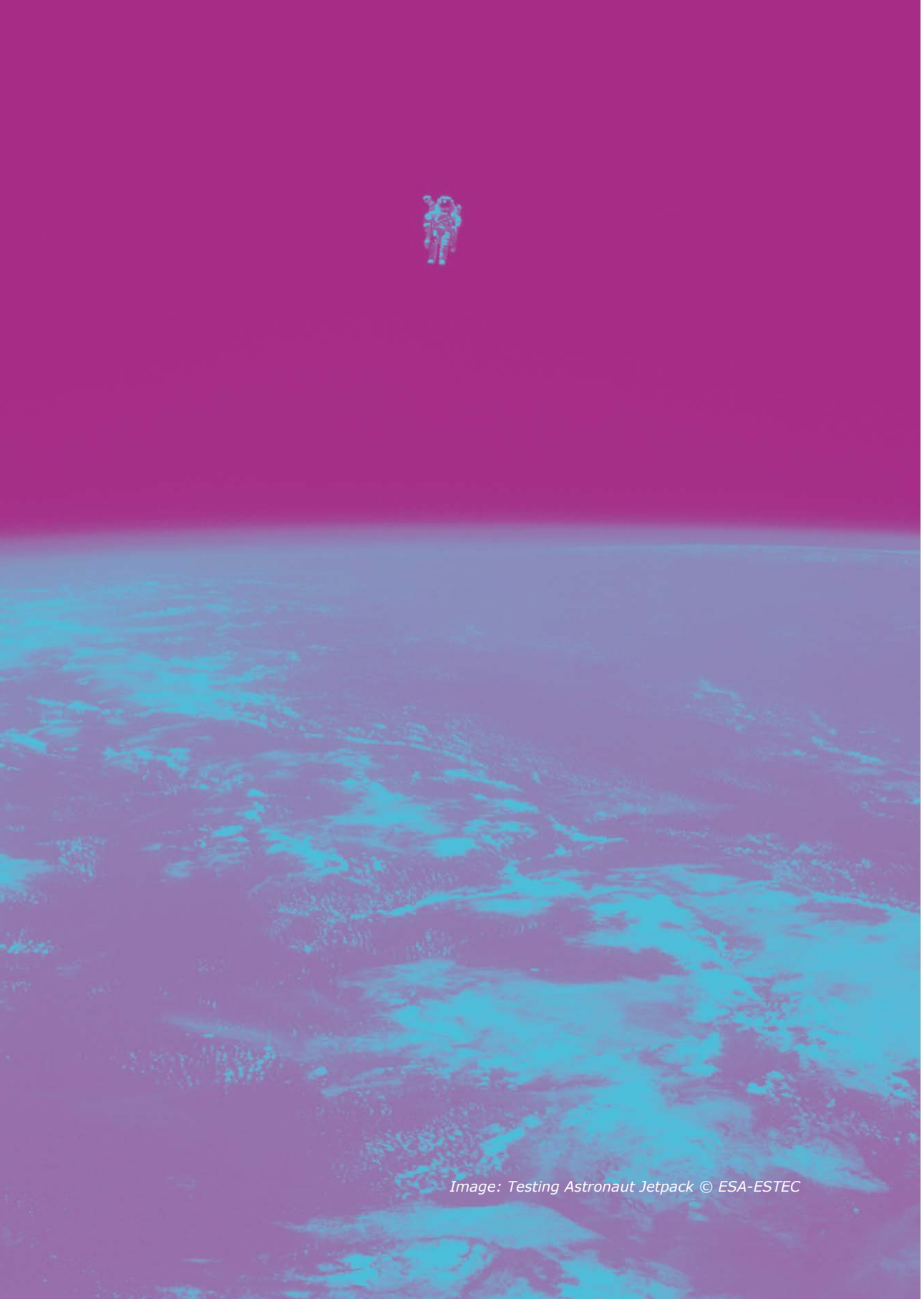


Image: Testing Astronaut Jetpack © ESA-ESTEC

Innovating for the Future:

Understanding the Global Trends Impacting Aerospace

The aerospace sector is poised to face significant challenges and opportunities in the aviation, space, and drone industries towards 2030. Several global trends, including ongoing armed conflicts, geopolitical tensions, and the long-term effects of the COVID-19 pandemic, are putting pressure on the global economy. Meanwhile, climate change and rapid technological advancements are transforming the aerospace sector, and the projected economic and world population growth of the Asia Pacific region is shifting economic superpowers[1], [2]. Also, there is an increasing societal pressure to contribute to Sustainable Development Goals (SDG's) of the United Nations. Action or inaction by both companies and governments on crucial global trends and challenges will have a major economic impact on global economic growth as well as for specific sectors. According to a recent report from McKinsey and the World Economic Forum this impact can range between -8 and +15% in Global Gross Domestic Product (GDP) growth in both near and long term[3].

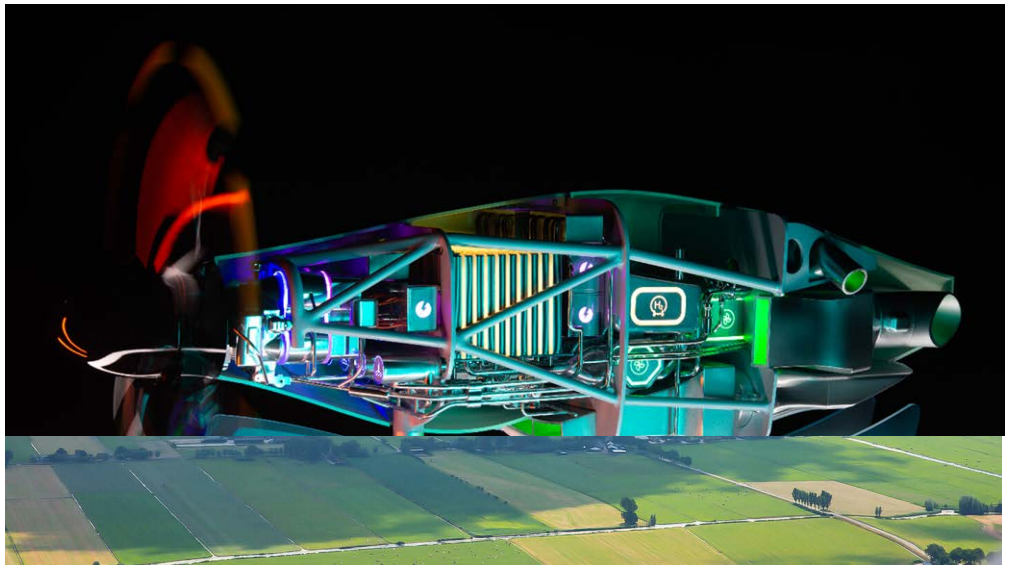


Image: Airbus. © Airbus sas 2022 photo by Hervé Gousse - Master Films.

Aerospace in the age of sustainability: Navigating the climate challenge towards climate neutrality

We as a global society are facing an existential problem. On our current path to fight global warming, we will exceed the absolute limit of 1.5C° in 2030. Sustainability is now the top priority as consumers, governments, and investors globally focus on reducing negative effects on the climate. This shift has major implications for growth ambitions in the aerospace sector, particularly in aviation, currently accountable for 2,8% of global CO_2 emissions. By 2050 the demand for flights is expected to be three-fold and emissions doubled if no actions were to be taken[4]. The European Commission has set the goal for climate neutrality in Aviation in 2050. Consequently, Airbus is executing its technology roadmap to bring a zero-emission commercial aircraft to market in 2035[5]. The shift towards net-zero will also require new standards in logistics, fueling systems, and infrastructure to accommodate zero emission aircraft.

The shift towards sustainability and reduction of waste has also led to the growing need for a circular economy and circular products. The European Commission is expected to introduce the Digital Product Passport, which will provide the composition of raw materials used in products and systems to boost recyclability and the circular economy. This trend of circularity will have profound implications for newly developed parts and systems for aerospace applications. For example, the development, testing, and certification of new renewable and eco-friendly materials and products for aerospace applications will most likely gain traction in the coming years[6].

For the space industry, climate change and sustainability present both challenges and opportunities depending on its subsectors. The upstream sectors in satellite manufacturing and the launch industry will need to find a balance between safety, costs, and environmental footprint. On Earth but also in space, where the rise of Space Junk is a growing concern while the Earth's orbit gets more crowded with satellites. This will affect companies operating satellite constellations as new regulations are imminent which force companies to clear satellites that are out of service, and they will not be allowed to burn in the atmosphere. On the other hand, the importance, the value and progress of satellite technology and instrumentation with regard to climate research and monitoring is rising to the top of priority lists within governments and global organizations. Led by ESA, the space industry will have significant societal and strategic value through Earth Observation (EO) data and its applications. For example, the Climate Space NL initiative is aiming to provide pinpointed CO_2 and methane emissions using satellite-based observations to assist various industries, including the aviation industry towards a net-zero emission society in the coming decades.

Zonnepark Rotterdam The Hague Airport © Koen Lauerij

Image: Robotics (Source: Sam XL, TU Delft)

Aerospace in a changing world: Demographics & geopolitics as key drivers

Urbanization

According to the UN the world's population is expected to grow from 7.7 billion to 9.7 billion in 2050. Today in 2023 around 55% of the population live in urban areas, producing 80% of the Global Gross Domestic Product (GDP) and more than 70% of global emissions. In 2030 the pollution living in cities will have grown to 60% and 70% in 2050[7]. While urban areas contribute most to economic growth, it can also lead to major issues in congestion, pollution, emissions, and social inequality. Nevertheless, this continuing trend of urbanization provide opportunities for aviation and the drone sector as demand for air transport in general is expected to grow further and for space the value of satellite data, communication technologies, and navigation in urban areas will increase.

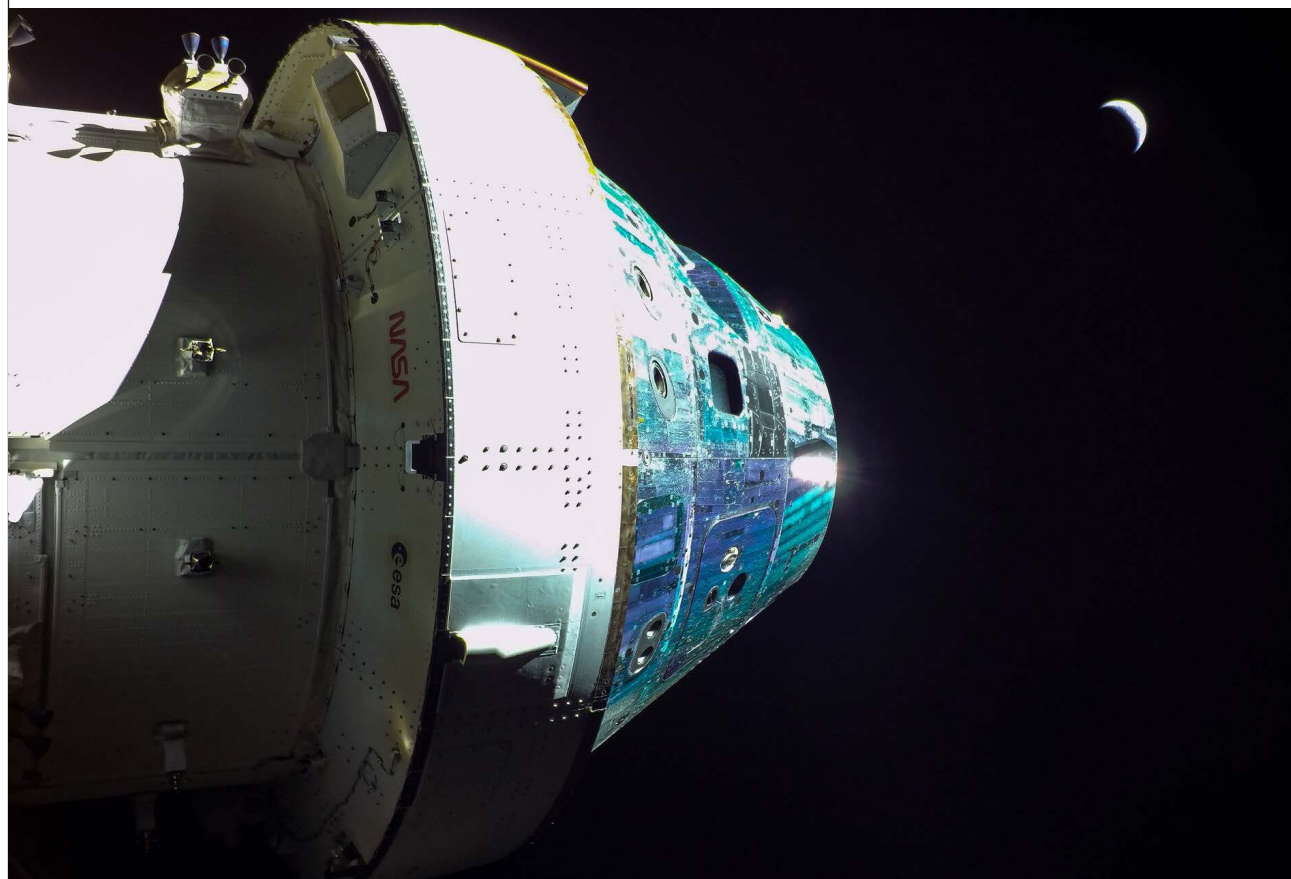
The Tightening Labour Market

At present, the age group of 65 and above already outnumbers children under 5 globally. In 2050 the elderly will outnumber adolescents between 15 and 24. Europe is leading this trend which has significant implications for near- and long-term workforce capacity and labour markets[8]. While economies are (moderately) growing, companies are struggling to find employees in a tightening labour market while needing to find ways to drastically improve productivity. As aggregate labour productivity growth rates in the EU (and the US) are declining by 0.2% annually due to several reasons, technology will need to be the key driver to push growth rates back up. Especially with the worrying labour force declines in the coming decade [9]. Furthermore, the changing priorities and principles of employees with respect to employer engagement in societal challenges such as sustainability, inclusiveness and (gender) equality will also impact global sustainable growth[3]. These challenges will need to be addressed by the aerospace sectors to be able to accommodate the growth in demand of products and services. However, it can also provide opportunities for services targeting productivity optimization and automation.

Adapting to Disrupting Global Events

While inflation rates are reaching record numbers, the fear of a recession can be sensed in most global markets. We seem to now live in a world where geopolitics can dominate capital markets. Disruptions and the effects of geopolitical events such as Brexit, the US-China trade war, COVID-19, the tensions around the semiconductor industry and the war in Ukraine have all shown how important resilience has become for companies and governments alike. The effects of the war in Europe, Brexit and COVID-19 have disrupted supply chains and slowed down globalization forcing companies, especially in manufacturing, to reassess their global value chains. The war in Ukraine has exposed the lack of strategic autonomy of certain countries in its reliance on crucial information from, for example, satellite data for defense purposes. The overall position of national defense departments and the strength of defense industries in the EU and its member states have also come under scrutiny. As tensions continue to grow globally and do not seem to cool down anytime soon, development of new advanced (dual-use) technology to improve the defensive strength within the EU will also have an impact on tech-based sectors such as aerospace. Thus, geopolitics will most likely weigh in a lot more in important decision-making processes within the aerospace sector in the coming decade.

Image: Artemis flight day 19: A slice of Earth © ESA-ESTEC



The Transition to Industries Without Borders

To cope with the increased complexity of technology cooperation between companies of different sizes and natures becomes more prevalent, characterizing the era of the business ecosystem or ecosystem economy. Technology-based companies need to understand which aspects, emerging technologies or challenges they can autonomously address, and which require partnerships with others to stay competitive. The new business ecosystem or ecosystem economy approach opens new evolutionary paths and possibilities for innovation beyond 'traditional' industries, sectors and company borders and unlocks new possibilities for growth and differentiation, including in the aerospace sector. It emphasizes the importance on cooperation with startups, scale-ups and innovative organizations in the long term, for example through different types of collaboration with accelerators and incubators, setting up R&D partnerships with startups rather than acquisitions or simply as suppliers.

Emerging Digital Technologies

The use of digital technologies such as AI, advanced robotization, and the Internet of Things (IoT) is transforming daily life for both consumers and businesses. These advancements in digital technologies and the sharing of data will continue to have a major impact on all aerospace sectors and industries. The successful implementation of these technologies and the utilization of data will present opportunities in areas such as process optimization, industrialization, product development and new business models. Digital technologies will also further enable us to address challenges such as in climate research and labour market shortages.

The Artificial Intelligence (AI) Revolution

AI and Machine Learning (ML) are tools that can vastly improve efficiencies, assist with difficult tasks, or introduce whole new business models. This fundamental digital technology is already being implemented in many different subsectors, including design, manufacturing, maintenance, and operations within the aerospace sectors. Market forecasts show that AI will be an enabling technology in almost all aerospace disciplines, with growth rates of approximately 43% from $467 million in 2021 to around $12 billion in 2030[10], [11]. AI is expected to accelerate Smart Industry implementation in, for example, optimization of manufacturing processes, and smart and predictive maintenance. It will also expand drone applications and markets, enable the development of autonomous systems in aircraft, drones, Advanced Air Mobility, and satellites. The scope and impact of AI applications that have recently been developed already show its potential impact on society and businesses. We may be just scratching the surface with examples such as ChatGPT, image creator Midjourney and computer vision tools like Landing.AI.

Furthermore, access to satellite data through Remote Sensing technology such as multi- and hyperspectral satellite imagery, navigation, and Radio Frequency (RF) data is improving due to expanding constellations and lower costs. Although not new, the rapidly expanding possibilities of AI and the improving access to satellite data is expected to lead to a big growth of Remote Sensing applications in the downstream space sector.

The Future of Automation

Combining emerging digital technologies can lead to heavy automation across various fields, creating faster, more agile, and more responsive business processes. This includes the use of AI in software for design and engineering, advanced robotics, but also in market forecasting and financial technology (FinTech). The trend in expanding industry 4.0 to industry 5.0, focusing on human-centric and assistive technology in automation and digitalization, will also be crucial in the implementation of future automation. The overall trend of hyper-automation will free up

Dutch solar array for the European Service Module of the Artemis Moon mission of NASA and ESA ©Airbus Netherlands

employees to focus on high-value activities that require human expertise, creativity, and problem-solving skills. And the shortage of technical talent in high-tech sectors will accelerate further automation as companies seek to remain competitive.

The Need for (Cyber) Resilience

In today's world, the increasing reliance on data and opportunities of emerging technologies such as AI has created a huge demand for high-speed data transfer and sharing of information. Unfortunately, this has also led to a significant growth in the number of cyber security breaches within companies. And as geopolitical tensions rise, there is a call for stronger information security and secure data sharing between companies and governments as cyber warfare continuous to advance. Yet the awareness of the risks of cybercrime and information security within many industrial companies is still lacking while reliance on data and digital technologies keeps increasing. It is often forgotten that satellite communication is fundamental to the latter. Cyber resilience in satellite communication is therefore an essential factor that needs addressing in the coming years to prevent spying, jamming or meddling with communication systems and data transfer by unwanted parties. On the other hand, new innovative technologies such as quantum promise to address some of these issues with, for example, quantum cryptography.

Unlocking the Potential of the Space-based Economy

Space superpowers like Amazon, SpaceX, and Virgin Galactic are attracting significant public attention due to their ambitions for satellite constellations, space exploration, and even space tourism. The commercialization of the space industry is driving down launch costs, leading to technological advancements like reusable rockets. The interest of public sectors, the transition to the new digital normal and focus on climate change are driving R&D investments in space technology. So much so that the space sector is expected to grow to $1 trillion by 2040, although investments may fluctuate[12]. The fast pace of innovation in space technology will drive further developments in the future space economy in such as the new race (back) to the moon, exploration of the solar system and in-orbit manufacturing.

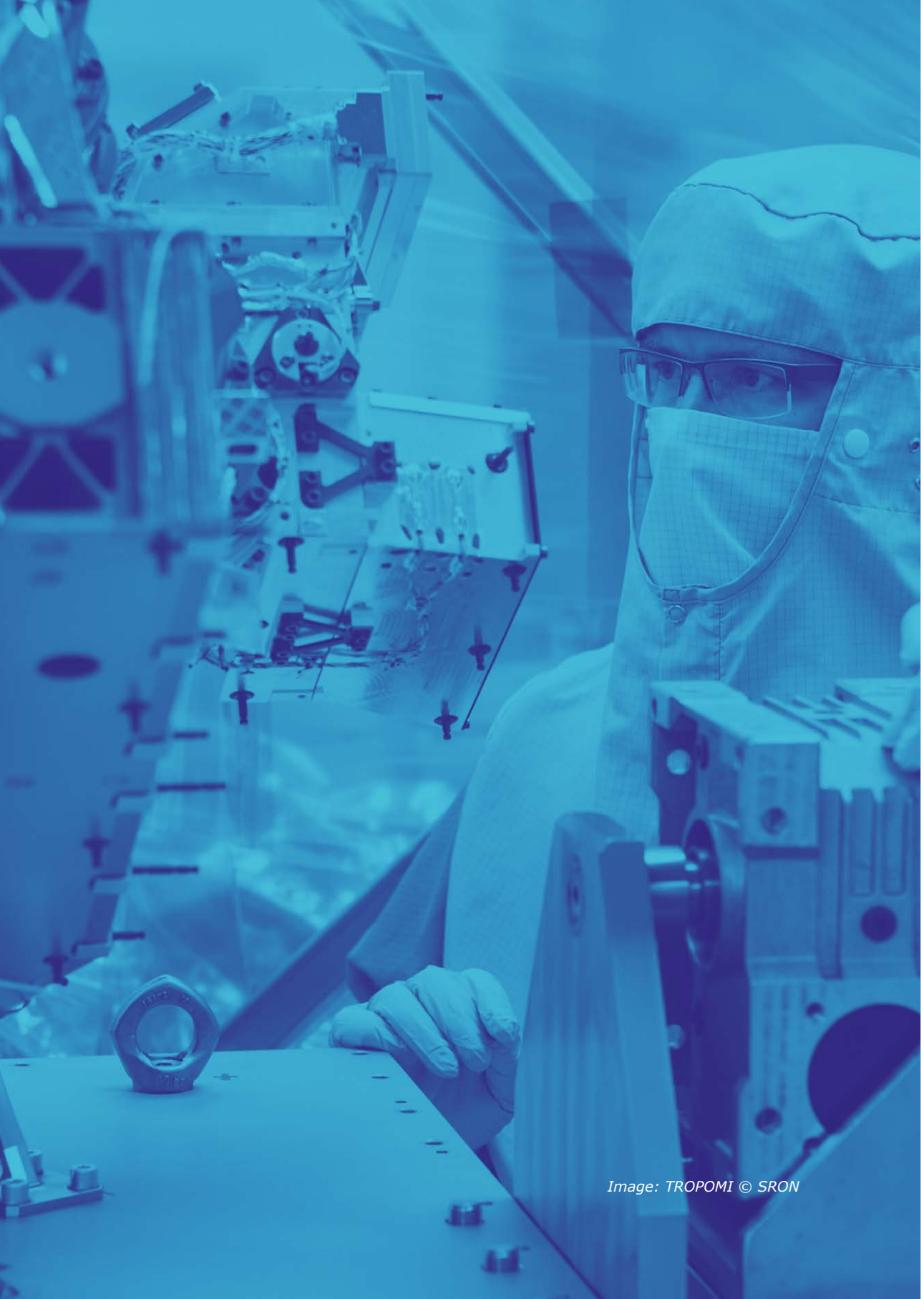


Image: TROPOMI © SRON

Market opportunities in Aviation, Space & Drones

The Aerospace sector is at the forefront of technological innovation and is poised to shape the future in numerous ways towards the sustainable and digital society described in the previous chapter. These global trends present a range of promising market opportunities in the aerospace subsectors, showing significant growth in all sectors.

Expected Market Growth

With the strong headwinds from COVID-19, record high inflation and the war in Ukraine, the Aviation industry is still expected to grow with a 3.9% CAGR towards 2040[13]. But to be able to achieve long term growth, sustainability is top priority. The global space sector (up- and downstream) has grown 9% from 2020 to a whopping $469 billion in 2022 and is expected to hit $1 trillion in 2040, drawing on the rapid commercialization and technological advancements while ramping up production rates[12], [14]. Additionally, both the aviation and space sectors are seeing opportunities in the defense industry due to growing geopolitical tensions resulting in increased investments and defense funds. In parallel the global drone sector, while still maturing, is already expected to grow globally at rates between 15-30% towards 2030[15].

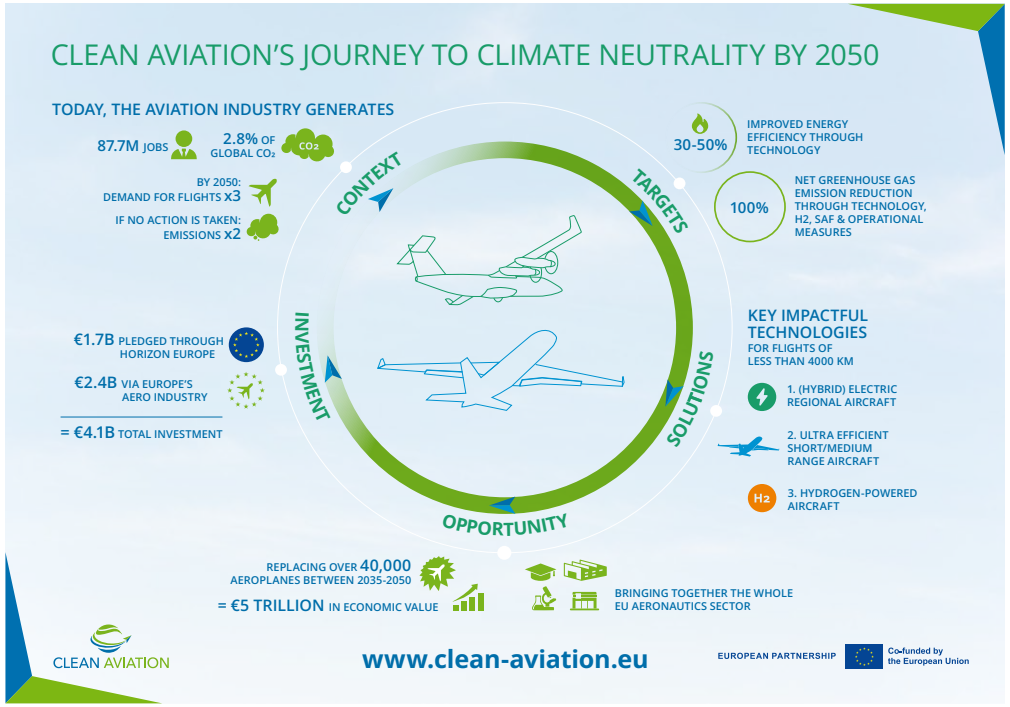
Building a sustainable future for Aviation

The Aviation industry is recovering more quickly than expected from the slowdown caused by the pandemic, followed by the demand for new and more efficient aircraft globally. With projected deliveries of some 39.500 aircraft by 2040, Airbus expects similar production rates compared to the Boeing Company with around 41.000 deliveries by 2041.

However, the Aviation industry is at a crossroad. With the expected growth of the industry and short-term demand for new aircraft, it also needs to initiate significant changes towards a sustainable and digital future. There is a drive to develop more efficient aircraft but a necessity to reduce its carbon emissions to net zero by 2050 and tackle non-CO_2 and noise issues as highlighted in previous chapters. These introduce numerous technological challenges and in turn, opportunities for the regional aviation cluster in aircraft design manufacturing, system and component suppliers and airport infrastructure.

Towards climate neutrality in 2050 approximately 40.000 aircraft need to be replaced between 2035 and 2050, resulting in an estimated economic value of €5 trillion (see figure 1). To stimulate technology developments the Clean Aviation Joint Undertaking program of the European Commission injects €1,7 billion of Horizon Europe funds for Research and Innovation projects in three main technologies: (hybrid) electric regional aircraft, ultra-efficient short/ medium-range aircraft and Hydrogen-powered aircraft. Additionally, in the coming years the Netherlands invests hundreds of millions in the hydrogen economy and stimulation of hydrogen usage through the National Hydrogen Program[16].

Figure 1: Europe's path to Clean Aviation. Source: Clean Aviation



CO_2 emissions per segment and range

2018

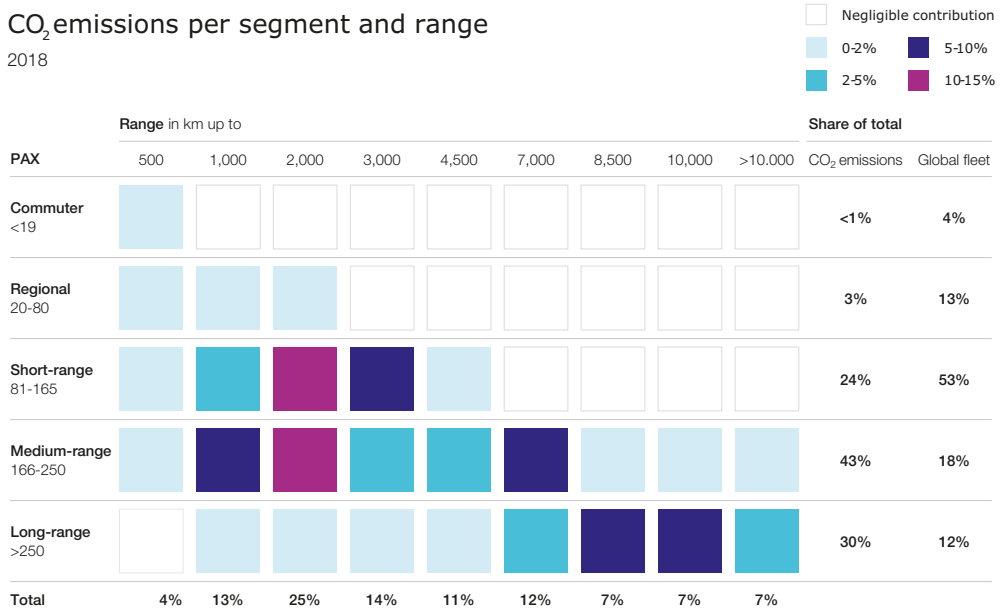


Figure 2: Source: Hydrogen-powered aviation, A fact-based study of hydrogen technology, economics, and climate impact by 2050

The novelty and required innovation necessary for this fundamental shift in aviation, lead to valuable and feasible opportunities for (smaller) innovative companies to develop sustainable technology. Although multiple projects and consortia have already jumped on different technological developments, stronger collaboration between these consortia and its start-ups, SME's and corporates could mitigate risks and increase the chances of global success in the region. The size of the zero-carbon aircraft market is projected to be $105 billion in 2050 with a cumulative size between 2021 and 2050 of $965 billion[17].

Powering Sustainable Flight

Larger aircraft in especially the regional, short and medium-range flights are responsible for a high proportion of the total emissions in aviation, accounting for approximately 70% of the total CO_2 emissions (see figure 2). To be able to make an impact, the sector needs to develop sustainable power train solutions for these aircraft types. Within the Clean Aviation program and other large scale EU initiatives, the European Commission is focusing on hydrogen as the main energy carrier in the shift towards climate neutrality, mainly due to the higher energy density of hydrogen compared to batteries. (Hybrid) Energy systems based on hydrogen fuel cells and batteries have the potential to service (sub)regional and small aircraft consisting of 76% of the total aircraft demand towards 2040[13]. While hydrogen burned in a modified gas turbine engines could power medium range and larger long-range aircraft. The latter consists of 10% of total market demand towards 2040.

Both existing aircraft manufacturers such as Airbus as well as newcomers in the industry like ZeroAvia, Universal Hydrogen and the Dutch company Conscious Aerospace (based in Zuid-Holland) are developing hydrogen powertrains for aircraft. As described in earlier chapters, hydrogen is either stored as gas or liquid (e.g. cryogenic at -253C°). Each having their advantages, disadvantages, and

challenges. For both configurations, there are still technological advancements and new technologies required in (sub)systems such as (high temperature) fuel cells, storage tank, thermal management, and electrical systems such as wiring, power electronics and motors.

Another contender to power zero-emission aircraft is battery electric, already in production for small general aviation aircraft. With efficiencies up to 80%, it is the most energy efficient option and could enable, for example, net-zero regional flights. The power density of batteries is currently the main bottleneck to being able to power larger regional and short-haul aircraft. Nevertheless, battery technology is rapidly advancing. The Dutch startup Maeve Aerospace (based in Zuid-Holland) is currently developing a battery-electric 44-seater aircraft. Also, advancements in battery subsystems and enabling technology such as packaging, cooling and power electronics require further developments and offer opportunities for the industry in our region.

Accommodating Zero Emission Flights

The focus on sustainable aviation, in combination with the rise of emerging (digital) technologies will drive airports to initiate some fundamental transitions. To accommodate zero-emission aviation, airport infrastructures will need significant modifications. Because hydrogen is gaining in credibility as a future aviation fuel, airports need to develop and implement changes in their infrastructure for the supply of hydrogen to the airport, liquefication (before refueling), and on airport distribution. Additionally, close collaboration with stakeholders such as aircraft manufacturers, airlines, fuel transportation services and local authorities will be necessary to develop new standards and procedures. The demand for green hydrogen will require close collaboration with local or regional hydrogen production hubs. The recharging of battery-electric aircraft will also require changes in infrastructure in, for example, readily available (green) electricity.

Circular by Design: Redefining Materials in a Sustainable World

Next to emission reductions, there is a growing attention and even upcoming legislative action to reduce material waste, overall material and manufacturing footprint, and stimulation of circular product development. It is expected that this transition will eventually drive aircraft manufacturers to look at sustainable materials and processes for aircraft and cabin (interior) components. In turn, this will lead to opportunities for suppliers of aircraft parts in the Aerospace Delta region where with its expertise in composites to develop circular products, manufacturing processes and/or bio-based materials. Breakthroughs and developments in bio-based or bio-sourced material composites could make composites more sustainable. In general, composites are easier to process and can be recycled into new products as they soften when heated, enabling new production techniques like welded assemblies and leading to innovative construction possibilities for airframes.

Green & Autonomous Airports

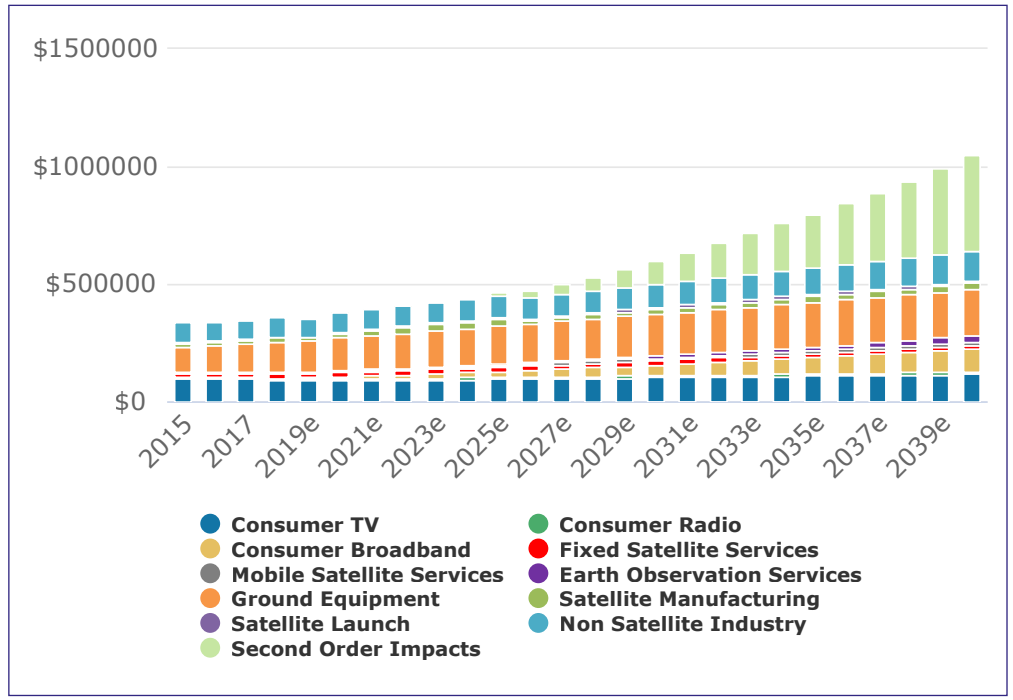
As new (digital) technologies emerge at a rapid pace, their potential for specific application in airport services and infrastructure and personnel, these technologies become more valuable every year. For example, Digital Twins of terminals can help improve processes, passenger experience and overall efficiencies. The development and implementation of autonomous technology offer a range of opportunities in dealing with the increased complexity of airport operations and processes and further support airport personnel in (heavy duty) tasks. It is expected that airport processes will become more complex in the coming decade. For example, due to the introduction of new fuel infrastructure necessary in enabling zero-emission aviation, resulting in more stringent safety requirements and complex ground operations.

Opportunities in Space

The total global space sector is forecasted by Goldman Sachs, McKinsey and Morgan Stanley to grow to $1 - 3 trillion in 2040 with more than 1400 companies, governments and startups active in the (new) space market. This shows there will be considerable market opportunities for both 'old and new' space in the coming years. However, the developments within the sector will present opportunities reaching far beyond the scope of the traditional space sector. Due to the booming demand for satellites and satellite services by governmental organizations and the vastly growing commercial constellations, the number of satellites orbiting Earth will grow to between 57.000 and 100.000 in 2030[18], [19]. The war in Europe and the resulting geopolitical tensions are also driving demand and investments in space (technology) for defense purposes from both commercial players and governmental organizations. Including in the Netherlands with the recent national Defense Space Agenda (DRA) which outlines necessary focus themes and investments towards 2027[20]. Furthermore, consumer internet services and ground equipment are major drivers for this growth, with the satellite communication (SATCOM) market growing to $132 billion by 2028[21]. SATCOM will also be one of the focus topics for defense in the DRA.

The growing demand for Earth Observation and data analytics solutions in public domains and commercial services, is expected to provide a big boost in downstream services, GNSS and EO enabled revenues, including the necessary (ground) instrumentation. In 2021 these revenues cross €200 billion and is expected to grow to €500 billion in 2030[22]. These growth projections indicate and quantify valuable

Figure 3: The Global Space Economy ($t).
(Source: Haver Analytics, Morgan Stanley Research forecasts)



opportunities for the regional aerospace industries in the coming years.

As mentioned earlier, the absence of an ambitious long-term national policy and agenda has been a limiting factor for the space sector in the Netherlands in seizing opportunities and staying ahead of global competition. Developments in the (national) space sector will have a growing impact on several national departments in areas such as defense, climate mitigation and infrastructure. To be able to act on (technological) developments, establish national strategic autonomy in access to space and to facilitate technology development in civil, defense and (climate) science applications, the national governance and policy in the space sector will need to climb on the national government's strategic agenda. That said, the national governmental is currently working on establishing a long-term agenda to support the above[23].

Shrinking Satellites, Expanding Opportunities

The demand for small (cube)sats leads to an enormous growth in projected small satellite launches from approximately 330 per year to 3000 in 2030[24]. Satellite and satellite subsystem manufacturing such as buses, completely integrated CubeSats, propulsion systems and solar panels will need to be produced in high volumes at lower costs to be able to address this growing but competitive commercial market. Regional companies in the upstream sector should start to implement digital technologies in the Smart Industry domain such as AI tools for Quality Control, advanced robotics and flexible manufacturing software. These steps are necessary to the industrialization of satellite, system, and component manufacturing. The growth in the market is also expected to drive continuous technological advancements and innovation in, for example, battery efficiency, lightweight solar panels, propulsion systems and improved power availability for payloads.

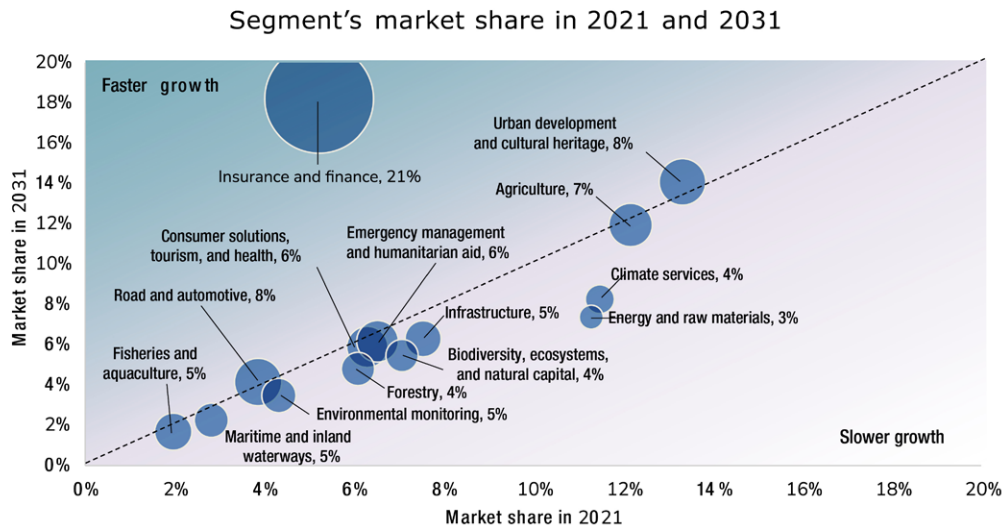
Beaming the Future: The Promising Future for LaserSatCom

The global infrastructure is increasingly dependent on our digital infrastructure and thus on satellite communication (satcom). But satcom via radio signals will meet technical and economic limits during the coming years as the availability of radio frequencies will eventually be insufficient to provide the required capacity while infrastructure costs are rapidly increasing. New technology in optical laser satellite communication aims to address this problem while improving the crucial issue of secure connectivity, using only a fraction of the required power and transfers data more than a thousand times faster compared to radio signal satellite communication. Established satellite operators such as OneWeb, SpaceX, Telesat, SES and Viasat are collaborating with investors and governments to address market opportunities in the space, on Earth, sea and airspace domains. Big European market players such as Airbus and Thales are developing roadmaps for the complete laser communication infrastructure. And OEM's in various countries, both established players and new entrants, are developing innovative equipment to target this future market which is expected to grow to €15 billion in 2040, including maintenance[25]. The Netherlands has been among the world leaders in the development and manufacturing of opto-mechatronic systems driven by the TNO, ASML and its supply chain. A Dutch consortium consisting of TNO, Airbus NL, Viasat, Demcon, VDL Enabling Technologies Group and the Netherlands Space Office (NSO) will develop cutting-edge LaserSatCom equipment as part of the National Growth Fund NXTGEN HIGHTECH proposal. The projected demand for laser satcom equipment also mean that production rates will need ramping up when the technology has been implemented. With the leading of the Netherlands, there are sizeable market opportunities in both the development as well as the industrialization of optical laser satcom equipment.

Rise of the New Space Economy, Downstream Services & Climate Action

As we are facing global challenges like climate change and the digital revolution we will increasingly rely on big data and AI solutions, mitigate natural and man-made disasters, and strengthen supply chains that are the basis for our daily lives. Earth Observation (EO), Remote Sensing (RS) and the European Global Navigation Satellite System (GNSS) will be crucial to develop innovative solutions to these issues and capture value in new market domains in the coming years. The diverse range of EO services, growing with different CAGR's from €2,2 billion in 2021 to €4,6 billion in 2031 (see figure 4 & 5), will play a vital role in climate modeling to battle climate change, help mitigate negative effects on bio-ecosystems and enable sustainable nutrient management in agricultural applications. The total EO, RS and GNSS market will grow with a CAGR of 9.2% from €200 billion in 2021 to €500 billion in 2030, with GNSS device sales and downstream services accounting for approximately 80% of these revenues[22].

The Netherlands is aiming to strengthen its leading position in scientific EO and respective instrumentation development to battle climate change through the National Growth Fund Climate Space NL initiative mentioned earlier. The project focuses on an independent (Methane, CO_2 and NO_x) emission monitoring system at the source level based on satellite data. It will use advanced detection tools, data processing and fusion and can image individual sources 35 times more accurately than what is currently available. This will be developed through the knowledge available in the Climate Space NL consortium and the New Space onboarding ESA Sentinel-5p TROPOMI solutions.



Note: The size of the bubbles represent the CAGR of each segment between 2021 and 2031.

Figure 4: Earth Observation Segment's Market Share CAGR's, EUSPA Market Report 2022

Distribution of revenue by segments (€m, 2021)

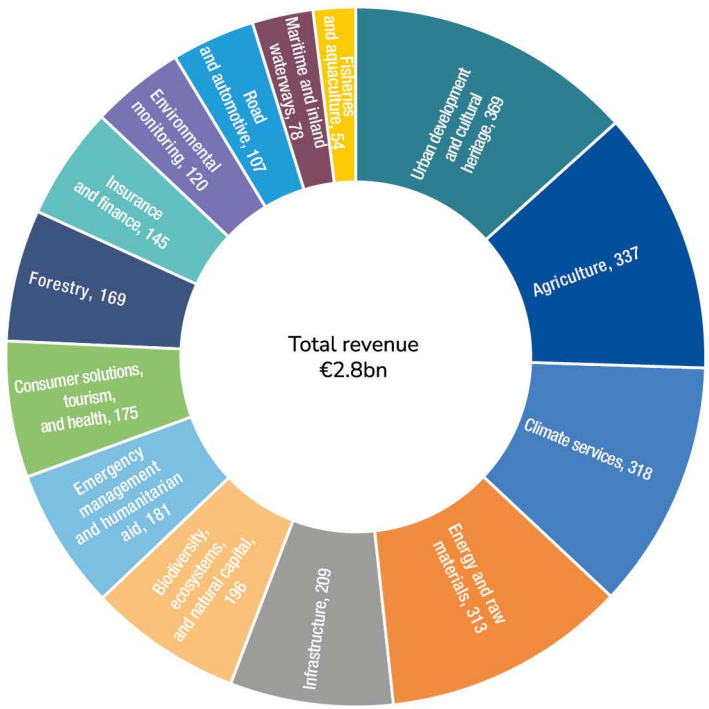


Figure 5: Earth Observation Segment's Market Share CAGR's, EUSPA Market Report 2022

Clearing the Path: Opportunities in Space Situational Awareness and Space Junk Mitigation

Nowadays, the number of satellites in orbit has increased to more than 3500 and, with all previously mentioned trends, will exceed 57.000 in 2030. With so many operational and defunct satellites orbiting Earth, the risk of possible collisions is now a new and serious topic that needs to be addressed by both the commercial space sector as well as governmental organizations globally. This issue is currently spiking interest in the topic of Space Situational Awareness (SSA) and space safety, meaning the knowledge and understanding of the location and function of space objects, and the monitoring and forecasting of Space Weather (SWE). The coming years, ESA will keep investing in technology for space safety (€731 million) and satellite navigation (€351 million) in, for example, space weather research with the VIGIL mission. As knowledge and technology related to SSA and SWE will become strategically more important to be able to track and monitor space objects[22]. And not only due to the danger of collisions. Defunct satellites also negatively impact the ozone layer due to chemicals being released when they re-enter and burn in the atmosphere. In turn, opportunities arise to develop innovative technologies to mitigate these risks and battle the so-called Space Junk problem in the coming years.

Opportunities in Drones

The commercial drone sector and its market applications have been growing exceptionally worldwide, as also recognized during the 2016 market study in the region. More recently, global reports for different drone subsectors show CAGR's between 6.5% and 25% towards 2030, still dominated by the US market. Well-renowned drone industry forecasters present a total drone market (including military) CAGR of approximately 24%, growing to $58 billion in 2030. Commercial applications (non-military) are expected to grow at a CAGR of 9.1% to $20 billion. However, market uncertainties due to sluggish regulatory action in, for example, BVLOS, urban flights (over people) and autonomous systems have to be addressed to accommodate the growth potential of commercial applications. Thus, such mainly regulatory uncertainties make it difficult to provide accurate forecasts and concretize long-term opportunities[15].

Growth of the UAV market is largely fueled by the trend of digital transformation, resulting in the need for data collection and data analytics in different markets and sectors. Demand increases for applications in existing markets (see chapter Main Markets and Areas of Expertise) as well as new markets in areas such as agricultural crop inspection, the process industry (storage tanks), infrastructure and wind farm inspection, and surveillance in seaports.

The Future of Urban Transportation & Advanced Air Mobility

Other opportunities in the drone sector include the emerging market in multiple Advanced Air Mobility (AAM) categories. Leading this emerging market is Urban Air Mobility (UAM). Mainly focusing on urbanization and congestion, UAM seeks to enable zero-emission transportation of 1 to 6 people in electrical Vertical Take-off and Landing Vehicles (eVTOL) in short (average of 18 minutes) flights from so called vertiports. More than 200 companies worldwide are working on UAM vehicles as the market is set to grow from expected lift-off in 2025 to $90 billion in 2050, with a fleet of more than 200.000 eVTOL's[26], [27]. These numbers promise significant growth opportunities in new high-volume business for, among others, component and material suppliers in the drone and aviation industry. Additionally, the implementation of UAM requires a completely new infrastructure and thus opportunities with vertiports, landing pads, charging infrastructure, connectivity, and maintenance services. Regions, including the province of Zuid-Holland, are already experimenting and will need to look into regulatory implications and actions.

Another emerging AAM market is in the drone delivery service, targeting profitability in last mile delivery in food ($60 billion in 2025[28]) and packages. Drones capable of such services are currently being developed. The success will also depend on advancements in the required logistical infrastructure in areas such as U space, landing pads, autonomous systems and delivery stations. Further developments in autonomous operations and especially regulations are required to facilitate the growth of the sector.

Image: Drone Light Show © Unmanned Valley

Shared challenges in the Aerospace Delta Zuid-Holland

To be able to sustain and grow its leading position in key areas, the Aerospace Delta cluster needs to address significant societal, economic and technical challenges by working closely together. Based on the analysis and input from the Aerospace Delta ecosystem, the market trends and opportunities, a list of shared challenges has been defined.

The Aerospace Delta ecosystem will need to act on fundamental market shifts, technology transitions and prioritize in addressing shared challenges. While focusing on improvements in production costs and industrialization continue to be necessary, the weight and impact of fundamental market shifts and technology transitions are growing significantly. For example, the shift towards sustainable technology and the rise of commercial space have become crucial topics in maintaining or gaining a competitive advantage. In order to tackle both societal and technical challenges, the development, implementation and also regulations of emerging (digital) technologies need to be explored and exploited. The sector needs to improve resilience in the face of cyber threats and disruptive geopolitical events while dealing with a shrinking pool of talent. And in the modern fast-paced economy, organizations will struggle to achieve their (technological) goals by themselves meaning (international) collaboration will become even more important.

Top 10 Shared Challenges

1 **Avert an Existential Climate Crisis**
As sector, we need to jointly act on the fundamental market shift due to the danger of climate change, while capitalizing on market opportunities for different technologies such as sustainable aviation and space-for-earth solutions in Earth Observation and Remote Sensing to address negative climate effects.

2 **Limit the Environmental Impact of Waste Materials**
By creating a circular Aerospace economy and new business models through circular product and system design, development of bio-based and eco-friendly materials, build efficient production and de-assembly processes.

3 **Attract Public & Private Funding**
The Aerospace Delta face challenges in attracting funding, especially for space (innovation) projects due to limited national budgets. This limits their track record in acquiring significant funds from EU agencies such as Horizon Europe, EUSPA and the European Defence Fund. Aerospace innovations typically require large-scale investments in complex materials, applications, and machinery, making them capital-intensive with long payback periods. Few public and private investors in the Netherlands are willing to invest under these conditions.

4 **Grow the Aerospace Talent Pool in a Tightening Labour Market**
The tightening and competitive labour market requires closer and a more open-minded collaboration between industry, schools and universities to build attractive educational programs across all Aerospace sectors. Improve connections between demand for skill and knowledge development from industry and content of (new or existing) curricula from educational institutions. Furthermore, the worrying labour market projections necessitate attention to productivity improvements.

5 **Valorize Key Competitive Knowledge Areas**
We need to improve the entrepreneurial environment to commercialize knowledge and IP from research and knowledge institutions to the industry in key areas of competitive advantage within the region such as optical and space instrumentation, Earth Observation and Remote Sensing technology.

6 **Capitalize on (Digital) Technology Transitions**
In gaining a competitive advantage in aerospace manufacturing and engineering, production rates need to be ramped up, costs need to decrease, while flexibility must increase. New (digital) technologies in engineering, production and maintenance offer opportunities for efficiency optimization, cost reductions and improved services. To be able to achieve this, the adoption of emerging technologies such as AI, advanced robotics and Digital Twins need to be accelerated in manufacturing and engineering environments.

7 **Deal with (lack of) Regulatory Action and Policy**
To be able to facilitate innovation and commercialization in novel technological areas such as Advanced Air Mobility, Laser satellite communication and sustainable aviation, support from the government is needed. To accommodate growth, improve our competitive position but also to establish a level playing field.

8 **Strengthen our Position in International Value Chains and Programs**
There is a lot of potential for stronger international collaboration through joint programs with complementary aerospace clusters in Europe such as Bremen, Toulouse and Emilia-Romagna. By actively branding activities and capabilities of the Aerospace Delta Zuid-Holland cluster and its stakeholders, we need to improve and strengthen our position in international value chains.

9 **Enhance the Startup & Scale-up Ecosystem**
There is a lack of (access to) Venture Capital and a need for a stronger entrepreneurial environment in which startups and scale-ups can commercialize their innovative ideas into successful products or services. The Aerospace Delta subclusters needs to collaborate with investors and the industry to support entrepreneurial success by helping startups and scale-ups in different phases of growth in realizing their full (commercial) potential.

10 **Build Resilience & Strategic Autonomy**
Awareness of the risks, and the necessary (political) actions needed in light of disruptive events such as geopolitical threats and uncertainties, cybercrime and (cyber)warfare are becoming key themes in all aerospace sectors. It will be important to (re)start discussions about innovative (dual-use) technology development to help build resilience in both private companies as well as for national safety and strategic autonomy.

Image: Moon from Space © ESA-ESTEC

Joint Mission, Ambitions & Strategic Focus

The Aerospace Delta has positioned itself on the cutting edge of innovation and technological development in key areas of expertise in the Space, Aviation and Drone domains. Based on input from the Aerospace Delta ecosystem, the market trends, opportunities and challenges, a set of ambitions are defined and a joint strategy is proposed to add focus and prioritize actions.

Our Joint Mission
The Aerospace Delta is committed to driving collaborative efforts that contribute to the big societal challenges facing the Space, Aviation and Drone sectors. By stimulating innovation, collaboration and knowledge transfer we drive forward advancements in aerospace technology and sustainable growth. The joint mission targets a number of key topics including climate action, regional collaboration, valorization, industrialization, talent development, and the entrepreneurial ecosystem.

Ambitions of the aerospace delta
Here, we will outline the region's ambitions which aims to position the Aerospace Delta cluster, improve competitiveness in the industry through innovation, and drive sustainable growth towards a more resilient and innovative aerospace cluster. These ambitions are collectively pursued in a joint strategy that addresses the pressing challenges, seize market opportunities, and enhance the cluster's competitiveness in the global aerospace industry.

- Contribute to climate action by stimulating and facilitating scientific projects, knowledge generation and commercialization of climate change mitigating, safety, sustainable and zero-emission technologies.
- Bolster the global competitive position of the Aerospace Delta by accelerating the development, implementation and commercialization of differentiating technology.
- Improve valorization from knowledge institutions to industry by optimizing joint research and development projects.
- Capitalize on underexplored market opportunities by stimulating and facilitating cross-sectoral and international collaboration.
- Create a strong regional aerospace labour market through talent development and productivity growth in response to the societal challenges. Thereby increasing the innovative and growth potential of the Aerospace Delta cluster.
- Create a thriving entrepreneurial startup and scale-up ecosystem with access to, among others, Venture Capital, shared facilities, and entrepreneurial development.

Strategic Focus of the Aerospace Delta
For the Aerospace Delta to address its challenges effectively and to realize its ambitions, several strategic themes are proposed that lay the foundation for the Aerospace Delta programs and projects towards 2030. The shared challenges and ambitions are clustered and/or prioritized based on input from the ecosystem. The resulting topics form a strategy that bring focus on what societal and economic challenges the Aerospace Delta can make progress on through collaborative action. It provides the first steps in how the ecosystem will overcome the foreseen obstacles. Later on, actions in the form of projects and programs are presented which aim to strengthen the aerospace cluster in Zuid-Holland.

- **Initiate (collaborative) programs targeting climate change and resource depletion** which stimulate and facilitate industrial research and technology development, and intellectual capital (knowledge), building on specific areas of expertise in the Aerospace Delta such as hydrogen-powered aviation, emission monitoring technology and (bio-based) composite (manufacturing).
- **Develop a shared innovation infrastructure** to improve valorization and technology/knowledge transfer to and from industry. Establish collective innovation centers, testing facilities and centers of expertise in close collaboration with industry, knowledge institutions and (sub)cluster. Creating easy access to these test and development facilities in the region. Focus on key challenges within industry and viable market opportunities.
- **Improve industrialization** of prototypes and products, from design and engineering to prototype development and cost-effective high-volume production. Exploring and exploiting (digital) technologies in engineering and manufacturing through (Smart Industry) projects and utilizing innovation center/field lab knowledge.
- Establish a joint Aerospace Delta initiative with incubators and accelerators to **support startups and scale-ups** in realizing their (growth) ambitions by improving access to finance and Venture Capital and offer services to develop their entrepreneurial skills.
- **Grow and cultivate the aerospace talent pool** by bringing industry and educational institutes closer together on specific (technical) topics on all educational levels. Develop joint initiatives that focus on industry challenges and new market opportunities.
- **Stimulate and facilitate (cross-sectoral) collaboration between (sub)clusters** in the Aerospace Delta sectors and with closely related sectors through, for example, joint programs and the organization of thematic events.

From Plans to Actions: Concrete Programs & Projects
In line with the strategic focus themes described in the previous paragraph, a list of concrete projects from the Aerospace Delta ecosystem has been formulated which are described in more detail in the Appendix. Multiple projects share common (technological) topics, address similar challenges or are working on complementary technology and are clustered in integrated programs (see next page).

The projects originate from various companies and stakeholders in the Aerospace Delta ecosystem and can be in different stages of development (Technology Readiness Levels), ranging from continuation projects and technology implementation to promising new ideas and the building of shared facilities. While projects may seek additional funding in the future, success will also depend on multiple factors such as project ownership, (financial) commitment and finding or aligning the right partners. The projects can be traced back to either specific shared challenges of the Aerospace Delta ecosystem or a combination thereof. The aim is to align complementary projects to facilitate collaboration, help speed up innovation processes and utilize, for example, shared facilities and innovation centers.

The projects are clustered in 5 programs that align with the strategic focus themes. The programs are: Sustainable Aviation, Automation & Digital Technology, Advanced Composite Materials, Space-for-Earth and Aerospace Delta Cluster Development. A detailed description of the projects can be found in the Appendix.

The flowchart on the next page provides an overview of the 22 projects that have been formulated with companies, knowledge institutions, field labs, including projects in collaboration with the province of Zuid-Holland and municipalities. There may be additional projects proposed in the coming years which are not included in this overview. Some are part of ongoing programs such as the National Growth Fund programs Luchtvaart in Transitie and NXTGEN HIGHTECH.

Strategic Focus

Initiate (collaborative) programs targeting climate change and resource depletion

Develop a shared innovation infrastructure of innovation center, Centers of Expertise and test facilities

Improving industrialization through implementation of (digital) technologies

Enhancing the start- and scale-up ecosystem

Grow and cultivate the aerospace talent pool

Stimulate and facilitate (cross-sectoral) collaboration between (sub) clusters

Programs

Sustainable Aviation
This program seeks to promote the development, testing, demonstration and implementation of new technologies, systems, and processes that reduce the environmental impact of the aviation industry.

Automation & Digital Technology
Centered on the development, testing and commercialization of cutting-edge (digital) technologies for automation and the industrialization of products/prototypes utilizing (digital) technologies.

Advanced Composite Materials
Research and development on innovative (bio-based) composite applications and advanced manufacturing processes.

Space-for-Earth
Key focus area in the (business) development, valorization and commercialization of downstream space technology and services targeting both commercial and institutional (public) markets in Earth Observation, Remote Sensing and Navigation.

Aerospace Delta Cluster Development
This program encompasses projects that have the goal to strengthen the Aerospace Delta cluster through collaborative initiatives between (sub)clusters, knowledge and educational institutions and/or government.

Projects

- Fieldlab Next Aviation
- High Power Battery Test Lab
- Advanced Electrical Wiring Interconnection Systems
- Flying Vision
- Smart Rotors 2.0
- DutcH2 Aviation Hub
- Laser Sat Innovation Center
- Airport Technology Lab (2.0)
- SCN AVATAR (continuation)
- Smart Production & Assembly of Solar Arrays
- Aerospace Systems Integration Test Facility
- Composite Launcher Structures
- ATG CompositesLab
- Bio-based Composites for Circular Aircraft
- Circular Thermoplastic Fuselage
- ESA Phi-Lab
- GNSS Center of Excellence
- Earth Observation & Remote Sensing Expertise Center
- Test Lab Innovative-/Advanced Air Mobility, Large Drones/RPAS
- Aerospace Innovation Hub @TUD International
- LDE Space Facility
- Aerospace Delta Collaboration

Image: SpaceX cargo spacecraft CRS-21 arrives at Space Station © ESA-ESTEC

Economic & Societal Impact

The aerospace sector has long been a driving force behind economic growth and societal progress in the region. As the European Union, the national government and the region continue to invest in aerospace technology, the Aerospace Delta Agenda shows the opportunities and projects that can yield significant results in terms of economic and societal impact within the region. From job creation to tackling societal challenges and fostering technological innovation, the agenda aims to initiate and stimulate far-reaching results for the Aerospace Delta region. With the support of InnovationQuarter in collaboration with the province of Zuid-Holland and the municipalities, this agenda seeks to act as a document that will boost developments in the industry in the Aerospace Delta.

Economically, increased investments in the aerospace sector will ultimately lead to further growth in research and development, GDP, generating a ripple effect across entire value chains in the High-Tech Systems and Materials (HTSM) sector. Near-term examples with ties to aerospace investments are the Luchtvaart in Transitie program (max. total of €383 million), the NXTGEN HIGHTECH fund (max. total of €450 million) and Climate Space NL (proposal). Many of the projects have the objective to strengthen the position of the regional industry in significant future international value chains. For example, to develop and position (new) technology, companies or consortia for new zero-emission Airbus aircraft program(s), in the developing laser satcom supply chain or in the early-stage development of the next Ariane rocket. Furthermore, these activities and projects will create new job opportunities, promote economic diversification, and stimulate local economies in the Aerospace Delta. The aerospace industry also has a multiplier effect, with each aerospace job supporting multiple jobs in related HTSM sectors, such as high-tech engineering, but also in energy (hydrogen), logistics, and maintenance. Moreover, aerospace exports of innovative products and services such as CubeSat systems, zero-emission systems, bio-based products and downstream services can enhance the trade balance of the region and contribute to economic competitiveness in the global market.

In addition to economic benefits, stimulating and driving advancements in aerospace technology, regional collaborative efforts and international positioning will have the potential to significantly contribute to key societal challenges. Looking at the Aerospace Delta programs and respective projects that have been formulated, there is great potential in regional contribution to the United Nations' Sustainable Development Goals. The programs and project have direct ties with big societal challenges such as sustainability, poverty, strategic autonomy, (cyber) security, and hunger. For example, the Space-for-Earth program and its projects seeks to contribute to quite some of the Sustainable Development Goals such as Zero Hunger (2), Clean Water and Sanitation (6), Industry, Innovation and Infrastructure (9), Sustainable Cities and Communities (11), Responsible Consumption and Production (12), Climate Action (13), Life Below Water (14), Life on Land and Peace, Justice and Strong Institutions (16).

Moreover, investments in aerospace have the potential to truly transform various industries, such as transportation, communication, and agriculture, leading to increased efficiency, sustainability, and connectivity. Aerospace advancements can also drive social progress, such as enhancing disaster response and monitoring through remote sensing and expanding access to education through satellite-based connectivity.

Overall, a well-supported Aerospace Delta agenda is anticipated to deliver positive economic and societal outcomes, fueling economic growth, creating jobs, promoting innovation, and enhancing societal well-being.

E-Flight Academy © Meemee Ploem

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Project 1 – Aerospace Delta Cluster

The region has 6 hotspots focusing on Aerospace markets and technologies. There is unexplored potential in stronger collaboration between the hotspots, for example, in addressing shared challenges and stimulating cross-sectoral technology transfer. Also, a cohesive and collaborative Aerospace Delta will help position the region as a competitive aerospace ecosystem in international value chains as well as to attract companies and organizations.

Prospective Partners
InnovationQuarter, NL Space Campus, Unmanned Valley, Technology Park Ypenburg, Delft Aerospace Campus, RHIA/RTHA, …

Problem to address
The Aerospace Delta has a rich palette of collaborations within field labs, campuses and accelerators. Too many are still working on islands, while there is already regular collaboration between subclusters under the radar. That collaboration between the various subcluster organizations needs to become stronger to leverage mutual knowledge, networks, talent and markets. Increasingly, technology in aerospace comes from other sectors. Vice versa, there are opportunities for aerospace technology in other sectors. Relationships with clusters outside its own bubble should therefore be strengthened to enable that technology transfer faster. Aerospace is an international business, which makes it even more important to position the cluster as one strong cohesive ecosystem in the international market.

Actions/activities
We envisage the following activities to be carried out within the project, among others:

- Organization of a yearly Aerospace Delta event to bring regional clusters and sectors together to discuss the progress of projects and address shared challenges.
- Organizing thematic meetings on common technology development, such as use of AI and machine learning, smart engineering, smart manufacturing.
- Organizing thematic meetings on the possible use of new biobased and circular materials and structures and other more sustainable solutions for aerospace products.
- Organizing meetings with other sectors in the field of technology transfer e.g. in the field of software development, biotech, electronics, mechatronics, etc.
- Organizing programs for start-ups and scale-ups in the field of market and investor readiness; using the knowledge and relationships within the regional network of mature companies
- Developing a mutual international brand, marketing language and international communication strategy.
- Explore and determine viable scenarios for an Aerospace Delta governance structure in collaboration with key regional stakeholders.
- Explore opportunities and challenges in the defense industry in collaboration with regional partners.
- Explore support in funding of (joint) initiatives and projects within the Aerospace Delta (Agenda)
- Develop a joint human capital approach.

Outcome of the project
A jointly supported Aerospace Delta program of activities and a jointly designed organization (incl. governance) with clear input from the various subcluster organizations that will carry out the activities.

Support to the regional ecosystem
A jointly supported program that allows the entire Aerospace Delta community to strengthen its mutual ties, where technology transfer between knowledge institutes and industry and between industry itself accelerates, where start-ups are better helped to find the right product-market fit and grow, where talent is trained together with the skills of the future.

Status
Project is still under development. Further coordination with partners will take place on the exact needs of the joint programs and activities to be developed. The aim is to start the program in the beginning of 2024.

Finance
Funding will come from the in-kind contributions of the partners and additional funding will be needed from regional and local governments.

Project 2 Laser Sat Innovation Center

The Laser Sat Com innovation center will support the Dutch industry to get a 0,5 to 2 billion euro annual market share in delivering instruments and subsystems for the Free Space Optical Communication market before 2040.

Prospective partners
TNO, FSO Instruments BV (a joint venture between Demcon and VDL ETG), Airbus NL, Viasat NL, others to be determined.

Problem to address
To be competitive in the new Laser Sat Com market, the Dutch ecosystem must prepare itself to produce (sub)systems and instruments in high mix and low volume at the lowest possible cost. This requires an environment where the required knowledge of products and production technology can be jointly thought out and tested. To promote cooperation, it is necessary to facilitate this in a practical environment, including the necessary infrastructure and instrumentation, where companies, knowledge institutes and universities come together and work together in as many integrated teams as possible on industrial/experimental research. It is also necessary to facilitate shared investments that are essential for the development of new manufacturing technologies and their applications, but which are not available at the companies and do not represent a profitable investment for the individual companies. In addition to cooperation within the laser Satcom domain, cooperation with other domains will also have to be sought, in particular the domain of “Smart Industry”. In this way, new smart production methods can be deployed in time to further increase the chance of success for the Netherlands in the Laser Satcom market.

Activities within the project
The project activities aim to develop and build the Innovation Center and make it operational.

- The coordination and monitoring of the 'Groeifonds Laser Satcom' program activities with focus on the industrialization and manufacturing aspects of these projects. Future R&D&E activities of institutes and industry will also be coordinated to optimize cooperation.
- Facilitating a practical environment where companies, knowledge institutes and universities come together and collaborate
- Coordinating investments for shared facilities that are essential for the industrialization of new technologies and applications, but which are not present at the companies and also do not represent a profitable investment for the individual companies.
- Coordinating and developing (smart) production technologies. Here, synergy is sought with the Smart Industry Domain.
- Training and attracting experts who can be deployed in the ecosystem.
- Promoting the Dutch Laser Satcom industry and strengthening the eco-system.

Outcome of the project
There will be office workplaces in the innovation centre and a practical area for carrying out projects. The practical area will have access to shared office space, lab/cleanroom areas, a shared pilot line with inspection, assembly, integration and test equipment and a shared workshop. The aim is to make the innovation centre permanent and to have it continue as an independent entity. Objective is to establish a pilot line for laser satcom equipment manufacturing.

Contribution to the regional ecosystem
The intended location of the innovation center is Delft and will be able to make a significant contribution to strengthening the cooperation of the high-tech-high precision industry in the region, primarily but not exclusively within the space sector.

Status of the project
The project was submitted as part of the Growth Fund proposal Next Generation High Tech Equipment and honored. Preparations to implement the project have started.

Finance
The cost of the Innovation Centre is projected at about €17 million. A contribution from the National Growth Fund has been requested.

Project 3 ESA Phi-Lab

The European Space Agency's (ESA) Phi-lab is a research and development facility that supports the development of innovative and new technologies and concepts for transformational Earth Observation solutions. It aims to strengthen the Earth Observation industry and research sectors in the EU.

Prospective partners
ESA, ESTEC, NSO, LDE-Universities, SRON, NLR, industry, Fablab, NL Space Campus

Problem the project addresses
Too many R&D projects that work on promising technologies for future space applications fail due to, among others, insufficient knowledge of its potential applications or lack of funding. The lab aims to facilitate knowledge and technology development in R&D project consortia often consisting of startups, knowledge and educational institutes and industry, by offering support in collaboration, funding and expertise from ESA, industry, research institutes and investors. The lab is located at NL Space Campus near ESA's European Space Research and Technology Centre (ESTEC), and it brings together experts from various space and non-space fields and disciplines.

The goal is to select and support the development and commercialization of potentially high-impact R&D project consortia starting from TRL 3 – 6, mainly from knowledge and research institutes and industry. The Phi-lab will provide access to funding (from ESA), shared facilities in the Fablab, a knowledge infrastructure and a potential path to industry adoption.

Actions taken within the project (activities)

- A facility will be built on the NL Space Campus to host the Phi-lab.
- The Fablab needs to be built to offer shared facilities for the manufacturing and testing of prototypes and to host the work and meetings of the interdisciplinary teams working on the projects.
- The Phi-lab program management will be coordinated and managed by NL Space Campus
- NL Space Campus together with NSO and ESA will develop the open call structure underlying the selecting of the eligible projects.
- The support team (PhD's, academic experts, market experts, investors) will be build

Supposed outcome of the project
Improving the valorisation of knowledge and commercialization of innovative technology by safeguarding and accelerating potential high-impact R&D projects (TRL 4-6) towards market introduction (TRL 9).

Contribution to the regional ecosystem
The Phi-lab will offer a facility and program in the Aerospace Delta region that accelerates technology development within startups and R&D consortia through shared facilities and services.

Status of the project
The ESA proposal is currently in the end-phase, the first open call for pre-proposals will be published shortly.

Finance
ESA and NSO provided a budget for setting up the Phi-lab. Additional regional funding may be required to help build a better supportive organisation, creating adequate shared facilities and be able to support more R&D-teams and startups. Public and private funding will be acquired to further boost projects in their end stage.

Project 4 –LDE Space Facility

While the growth projections for space are very promising and the sector is mostly perceived as interesting by the public, the industry, including ESA ESTEC, is struggling to find (technical) talent to accommodate the foreseen growth. The LDE Space Facility Projects aims to address the challenges of growing and developing the talent pool in space through a collaborative effort by the Universities in Leiden, Delft and Rotterdam.

Prospective partners
University of Leiden, Delft University of Technology, Erasmus University Rotterdam (LDE), Inholland, LIS, ESA ESTEC, NL Space Campus

Problem the project addresses
Although educational institutes show increasing interest to work on space topics (together), there is still limited interaction between the regional space ecosystem and the educational institutes. An important reason for this lack of collaboration is due to insufficient facilities for teaching courses and conducting (industry) projects. The idea to build a LDE Space Facility on the NL Space Campus will address this issue by providing a physical campus to teach not only space related courses but also stimulate collaboration with related research domains such as Artificial Intelligence and data analytics. The campus will offer shared facilities to conduct research and tests, build prototypes and stimulate interaction of students and teachers with startups and companies on and near the NL Space Campus. With the important goal to facilitate stronger collaboration between education and industry to improve the alignment of education with industry needs, the LDE facility will focus on initiating joint industry-education projects, ranging from PhD's to short term and team-based internship projects.

Actions taken within the project (activities)
- Align the interests of the potential industry and educational partners by gradually building more and more interactions between them and ESTEC and industry (through ThesisLab, student teams, student projects)
- Explore and build the business case in collaboration with key stakeholders.
- Attract funding.
- Start developing and building the facilities

Contribution to the regional ecosystem
The LDE facility will help support the improvement and growth of the aerospace talent pool in the Zuid-Holland region, thus contributing to one of the major shared challenges of the sector.

Supposed outcome of the project
A LDE Space Facility on the NL Space Campus will improve collaboration between education and industry through joint projects, thereby improving the quality of educations, improve alignment with industry needs, increase interest of students in space (technology) through better industry involvement and help grow the supply of new knowledge and talent to the regional industry.

Status of the project
At the moment potential partners are identified and activated.

Finance
TBD

Project 5 GNSS Center of Excellence (Noordwijk)

The market for Global Navigation Satellite Systems (GNSS) is set to grow steadily the coming decade. With the GNSS Center of Excellence the project partners aim to create awareness of GNSS applications and offer services to improve GNSS-based applications, while improving commercialization and technology transfer.

Prospective Partners
CGI, S&T, NLR, NSO, Min I&W, NL Space Campus

Problem the project addresses
The use of these Navigation systems through satellite constellations (called GNSS – Global Navigation Satellite Systems) are already deeply nested in our modern economy. However, we often do not realize it. For example, the positioning functionality of these systems is in use in aeronautical precision landing systems, asset management and autonomous vehicle technology. But they also provide accurate timing information, making it possible to synchronize devices across the globe to within several nanoseconds, essential for operation of national power grids, international finance, global communication (internet, mobile networks) and the Justice and Security domains.

Disturbance or failure of GNSS systems could/will have far-reaching consequences. This current and increasing reliance on GNSS also increases the awareness of their (intended and unintended) shortcomings and vulnerabilities. The GNSS Center of Excellence (CoE) will offer Risk and Research services to governmental organizations and companies for GNSS (market) applications. For example, by being able to monitor jamming and spoofing activities, and predicting GNSS quality. A test center needs to be developed to offer Test and Qualification services through, among others, testing facilities with the goal to stimulate development and qualification of GNSS equipment.

Actions taken within the project
The GNSS CoE will focus on these actions:
- Coordinate and manage GNSS CoE services with the consortium partners.
- Create a Public Private Partnership (PPS).
- Build a test center where companies, knowledge institutes and universities collaborate on GNSS application development.
- Facilitate and stimulate use cases and projects of GNSS technology such as GNSS for Ambulances, Advanced Air Mobility, Autonomous Vehicles and Agricultural applications.
- Offer testing and qualification facilities for GNSS equipment.
- Create awareness of the GNSS function for critical infrastructure.
- Expand with potential (international) partnership/ members, like Navcert and Fokker Services.
- Establish a healthy project base for the CoE.

Supposed outcome of the project
The GNSS CoE will offer a facility in Noordwijk with a network of experienced companies where governments and companies can collaboratively develop, test, de-risk and qualify specific GNSS applications.

Contribution to the regional ecosystem
The facility is located in Noordwijk, with their founding fathers operating from the Zuid-Holland province, further strengthening the regional space (downstream) ecosystem by building GNSS expertise to NL Space Campus cluster in Noordwijk. Furthermore, the project aims to facilitate growth of the downstream sector and stimulate GNSS value-added services within the region. By bringing technology development partners and users together the fragmented NL GNSS eco-system also strengthen itself with the European eco-system.

Status of the project
After 5 years of informal preparation activities the GNSS CoE formally kicked off and signed the covenant in September 2022. Currently regular BD activities take place, and a formal project has been launched. As well as a connection with NDA towards a similar center in Czech Republic and potential new members like NAVCERT and Fokker Services.

Finance
TBD

Project 6 – Earth observation & remote sensing Expertise Center (Noordwijk)

The Earth Observation, Remote Sensing and GNSS market will grow from €200 billion in 2021 to €500 billion in 2030. This project will strengthen the position of the Aerospace Delta region as EO and RS ecosystem to be able to address this growing market while improving commercialization and valorization of EO technology and supporting start- and scaleups in this process.

Prospective Partners
Groundstation, dotSPACE, CGI, S&T, SpaceNed, PZH, NL Space Campus, SBIC, NSO, LDE…

Problem the project addresses
The downstream sector in the Aerospace Delta region has a lot of potential, working on innovative solutions in Earth Observation (EO) and Remote Sensing (RS) technologies in, for example, critical climate research and commercial services. Meanwhile continuous breakthroughs in Artificial Intelligence and data analytics in combination with low-cost and wide-range access to satellite data expose a wide range of new addressable markets. However, downstream solutions are often difficult to scale, offering point solutions and commercial sectors are still mainly unaware of the value of downstream solutions.

To be able to accelerate the downstream sector and realize both economic (commercial) and societal (climate) impact, typically inexperienced or unwitting startups and SME's that develop downstream solutions would benefit greatly from support in entrepreneurial skills, professional network, and market- and investor readiness. The Groundstation platform and partners aim to collaborate and act as a Expertise Center to support regional downstream businesses, grow as a competitive regional downstream sector and create an attractive downstream ecosystem.

In parallel, the Groundstation platform will act 'Market Maker', facilitating both business development and societal impact by actively exploring and showcasing potential market applications with EO, downstream services and RS technology. The platform will support (international) governments and companies solving major societal challenges such as climate change, food and water shortages and energy supply either through dedicated industry projects or facilitating EU calls. The EO and RS Expertise Center aims to add the facilitation of (new) satellite data market applications in key sectors of the region such as Agriculture, (Offshore) Sustainable Energy and Maritime.

Actions taken within the project
The project aims to address different challenges and aspects of the downstream sector within the region through the following actions:

- Initiate a market study on EO and RS applications to determine opportunities in specific key sectors within the Aerospace Delta region, based on the translation of the EUSPA report to the Dutch market by SpaceNed(?).
- Grow and develop the Groundstation platform to 9.000 active stakeholders and 10.000 platform visitors to stimulate business development within the downstream sector.
- Build a cohesive regional network through the Groundstation platform and other regional partners to create an Earth Observation & Remote Sensing Center of Expertise that (1) supports growth of downstream startups and SME's and (2) acts as platform for companies and governments to explore downstream applications market opportunities. Either through Horizon/ EU calls or through dedicated (regional) projects.
- Develop a program for downstream startups (and SME's) to develop (soft) skills in entrepreneurship, market and investor readiness.
- Develop a program for the exploration of EO and RS market applications together with industry partners in key regional sectors.

Supposed outcome of the project
A growing and entrepreneurial regional downstream ecosystem that helps solve societal challenges and drives economic impact through Earth Observation and Remote Sensing within the Zuid-Holland region. The EO & RS Center of Expertise will be created to facilitate sustainable growth of the sector and its stakeholders by offering development programs for startups and a platform for market opportunities.

Contribution to the regional ecosystem
The EO & RS Center of Expertise will support growth of the downstream sector within the region. It will help to position the Aerospace Delta region as EO & RS hotspot where downstream startups and companies can develop themselves and where governments and companies come to find solutions using satellite data. Furthermore, it will actively facilitate and stimulate innovative applications of EO & RS to regional sectors such as agriculture and the offshore industry.

Status of the project
The project will expand the Groundstation and PZH collaboration with regional partners. First steps to start the project have been taken.

Finance
TBD

Project 7 – Aerospace Systems Integration test facility

To make transition for new technologies we need to increase the regional capability in systems integration knowledge and testing/certification; Necessary because in Zuid-Holland we house the main Dutch propositions for sustainable aviation both electric and hydrogen-based initiatives. There are many synergies between electric and hydrogen solutions for zero emissions aviation and having access to facility for sub-systems and full iron bird systems integration complimented with digital simulation techniques and solutions will help enhance the capabilities.

Prospective partners
Conscious Aerospace, Maeve Aerospace, Saluqi Motors, Zepp Solutions, Cryoworld, TU Delft, Inholland. We would like to explore how knowledge and educational institutes can participate as well.

Problem the project addresses
System Integration knowhow is not a core competence in Holland as traditionally we do not have a systems industrial base. We have focused on structures and materials in which we are a global market leader. Yet, systems is the area that provides most opportunities for innovation in aviation and possibilities for new startups to emerge, point in case Conscious Aerospace and MAEVE.

Proposed solution
Knowledge comes from experience and hands on testing. For testing, there are a lack of sizeable test facilities in the region, such environments are expensive to set up and run, creating a flexible environment would create a more efficient solution. To achieve this, we need to establish an Aerospace Systems Integration Test Facility. To make most efficient use would be to create a partnership for Aircraft Systems Integration whereby companies can work on their own proprietary product but have open access to all facilities as well as the education institutions and teams have access to develop their knowledge and R&D. We want to compliment this with an Aviation Systems Academy for Student Teams, such as Dragonfly (electric) and AeroDelft (Hydrogen) as well as provide support to create more systems engineering internships, as talent creation is a critical element of our ambition. They student teams have done very well on limited budgets, but they will see higher costs they cannot afford as their solution scale up, for this they need significant support from the ecosystem and the province.

Outcomes
- System integration knowhow
- IP creation on systems
- Products for system controls
- Increased talent throughflow from TU Delft and local schools into aviation

Contribution to the regional ecosystem
Will position the region as the leading Systems Integration region in NL and will attract more relevant stakeholders to the region. Will provide strong links to schools and universities creating the possibility of more talent to stay in aviation. We will be the showcase for the region on sustainable aviation capabilities for global OEMs.

Status of the project
In definition phase, will accelerate when NGF funds have been received.

Finance
Total costs will be approximately €20M. The rest of the funding will have to be determined through other public and private investments.

Project 8 – High Power Battery test lab

For flying fully electric and zero-emissions the development of aviation grade battery systems are crucial. Battery development is rapidly improving on energy density, (dis)charge speeds and life span. To use high power batteries in aviation much more research and testing must be done and therefor the availability of a battery testing lab is needed.

Prospective partners
Meave Aerospace, Forward Engineering, Airborne, SVT GmbH, TUT Rheinland, Frauenhofer Institute, Atlas Engineering, DNV, EAS Engineering, TU Twente, Titan Batteries, LeyderJar, TU Delft

Problem the project addresses
The demand for battery electric drives in all kinds of sectors of society is growing. Dutch companies are responding by developing their own battery technology. However, the availability of adequate battery test facilities in the vicinity is lacking; most modern and advanced test facilities are located in Germany and are expensive and often require long project lead times which makes these test for rapid battery prototyping prototypes to be tested quickly and optimized after testing.

Activities within the project
- Definition of requirements and setup specifications for continuous R&D/prototyping-based battery testing.
- Definition of usage and pricing of the testing facilities.
- Identification of systems/tools incl bill of materials and purchase/growth roadmap.
- Definition of safety specifications, safety procedures and environmental requirements
- Selection of partners, vendors and location for setup and operation of test facility.

Supposed outcome
A fully operational battery test facility for ‘unofficial’ prototype testing of battery concepts, with a clear roadmap to growth to increase test capabilities (testing of varying battery form factors, sizing, topologies etc.).

Contribution to the regional ecosystem
Currently testing is done on individual basis and with labs in NL/DE/UK. This proposed battery lab gives the opportunity to regional/national parties within the battery-electric ecosystems to make use of a professional testing environment with rapid prototype testing of high energy dense battery systems. The testing environment will not be limited to aviation application but will also be useful for other use cases like automotive or shipping. The first operational set-up of the testing lab is foreseen at Technology Park Ypenburg.

Status
Project is under development.

Finance
TBD

Project 9 – Flying Vision

Flying Vision is a sustainable aviation ecosystem in which TU Delft, Royal NLR, Royal KLM and Royal Schiphol Group as well as Airbus (Original Equipment Manufacturer (OEM)) are partners from the start. The goal of Flying Vision is a climate neutral aviation in 2050. Roadmaps will be defined on what will be needed. Innovations will be accelerated by developing new technologies in co-creation. By linking the end-users, manufacturers, suppliers, research institutes and academia within this ecosystem, Flying Vision will contribute significantly to the transition to a climate neutral aviation. As Flying Vision has an open method of operation striving for impact, there is room for new (regional) entrants in the near future.

Project definition
The Flying Vision partners will structurally address challenges and opportunities of climate-neutral flying by 2050 and will carry research and technology development on a global scale. It sets up an open system in which various parties work in co-creation on these challenges. As there is no silver bullet to "solve" climate neutral aviation, a system of systems approach is required, a holistic view involved with diverse players in the field of aviation. Flying Vision will start with the focus on 4 topics:

- Aircraft with the lowest energy budget
- Green aircraft propulsion and energy-carriers
- Green customer journey
- Talent

Collaboration on those topics offers partners opportunities to explore scientific, operational and economic elements of the sustainable aviation challenge together. The abundance of talent, research and education in the region plays a key role in attracting the right partners.

Activities within the project

- Setting up Flying Vision with governance arrangements, accommodation and an organizational set-up (staffing) (part of Luchtvaart in Transitie)
- Creation of the first versions of the roadmaps with research activities to be implemented. Activities will be carried out to provide a first test of new ideas. For example, to test whether the idea is promising enough to investigate it further in a larger project.
- Flying Vision will initiative potentially facilitate and carry out R&D projects. Funding will be looked for in programs like Clean Aviation, Horizon Europe, national and international tenders.

Supposed outcome
A fully operational open research environment with a number of different (inter)national research partners, working in co-creation on technology bringing climate neutral aviation closer to reality.

Contribution to the regional ecosystem
The ecosystem is working on out-of-the-box solutions for sustainable aviation. The outcomes of the studies and projects will provide opportunities for valorization with the regional business community and will contribute to the regional initiatives already underway in green propulsion flying including novel materials, high-power electrics (i.e. EWIS), new propulsion methods (i.e. HAPSS), including future airport operations (i.e. RTHA) and talent development.

Status
The project has been submitted for granting from the National Growth Fund as part of the proposal Luchtvaart in Transitie and has been rewarded.

Finance
€10M is available from the National Growth Fund to set up Flying Vision and carry out the first phase of studies.

Project 10 – Aerospace Innovation Hub @TUD International

The Aerospace Innovation Hub@TUD opened its doors in April 2020. They operate as a start-up and are preparing themselves, after two very successful years, for the next phase. An important part of the next phase is the connection to the scale-ups from the Aerospace Innovation Hub community by, among others, creating a logical landing place for the scale-ups of the Aerospace Innovation Hub. Furthermore, the Aerospace Innovation Hub will take a more regional position by connecting Aero and Space Innovators in the region. The regional position will be followed up by an international position. The Aerospace Innovation Hub will connect to international players and international communities – positioning the region as THE Aerospace Hotspot in Europe. With this also making use of the strong position of TU Delft Aerospace Engineering in the world.

Prospective partners
ISISpace, KVE, Airborne, Collins Aerospace, and many more to join

Project definition
Currently, the physical location of the Aerospace Innovation Hub@TUD comprises is the top 4 floors of the high rise building at the Faculty of Aerospace Engineering. There is office space available for startups during their first endeavors. We identify two parts of the project:

One part of the project is to create logical clusters where the startups and scale-ups of the Aerospace Innovation Hub@TUD International that have "outgrown" their office, can continue their journey of growth. Location will be dependent on the specific focus of the scale-up; focus on airport infrastructure, on talent, knowledge, or others.

The second part of the project Aerospace Innovation Hub@TUD International is to enhance community building and expand the scope from regional to international. Starting off with a very important regional responsibility by connecting the aerospace innovators in the region.

Furthermore, steps will be taken towards a more international positioning – the Aerospace Innovation Hub@TUD being THE place to be and to connect with in Europe with respect to innovations in Aerospace Engineering.

Activities within the project
Regarding the first part of the project:

- Identify possible landing places for the scale-ups or ”outgrown” startups that need a location to further their endeavors. With this an analysis will be done regarding common wish lists, for example regarding testing facilities etc.). Locations to consider are Rotterdam The Hague Airport, Unmanned Valley Valkenburg, NL Space Campus, TPY, TU Delft Campus.
- Locations will be identified and explored to see how we can further help and elaborate. With regard to the second part of the project- further the community building from regional to international;
- (Thematic) Events will be organized at the Aerospace Innovation Hub@TUD to connect the “Aerospace Innovators” in the region (SME’s, Scale-ups and others);
- Furthermore, the collaboration with international Aerospace players will be further explored and partnerships will be set up – examples:
- Collins Aerospace, OHB, Safran, Ariana Group

Supposed outcome
The outcome of the project will be the creation of several clusters of aerospace scale-ups in logical places in Zuid Holland (close to talent, knowledge or specific facilities).

Furthermore, the Aerospace Innovation Hub will enhance community building by “connecting Aerospace Innovators” from the region as well as in an international perspective.

Contribution to the regional ecosystem
With a mission to “connect Aerospace Innovators” this project of the Aerospace Innovation Hub will contribute to making the Aerospace Delta region THE Aerospace hotspot in Europe. Starting with reinforcing the role in the regional ecosystem and expanding the horizon to connect the region and community to international networks. This will strengthen the position of the regional ecosystem. Also, the clustering of relevant and promising startups and scale-ups will help in the visibility of the regional ecosystem.

Status
Currently in development

Finance
TBD

Project 11 – DutcH2 Aviation Hub@TUD International

Hydrogen is key to decarbonize aviation: hydrogen-powered aviation could be the most economical net-zero technology for ~80% of current commercial air traffic at Rotterdam The Hague Airport (RTHA). The airport serves destinations mostly in the mid- haul distance for which hydrogen flying is expected to be the most economical sustainable solution. Therefore, the airport is preparing itself to accommodate hydrogen flying in the near future.

Prospective partners
The Zuid-Holland region has hydrogen knowledge and infrastructure to experiment and drive change. With regional and international partnerships, we can establish RTHA as the frontrunner on hydrogen aviation, detailing hydrogen production infrastructure scenarios, building a network of airports that pre-invest in required infrastructure, advocate for required regulation and work with airlines to drive adoption of hydrogen flying. Current partners including Schiphol Group/RTHA, NLR, TU Delft, Shell, Vopak, Conscious Aerospace, ZeroAvia, Unified International …

Project outline
Following up on the cooperation commitment announced last year to launch the first gaseous hydrogen-electric commercial flight, this specific program will focus on serving the first gaseous hydrogen flight with ZeroAvia and Shell and the first liquid hydrogen flight with Conscious Aerospace from Rotterdam. This includes operation at the airport, developing on-the-ground infrastructure and operations to satisfactorily pilot production, distribution, storage, and dispensing of hydrogen for aviation, leading towards decarbonizing the whole airport ecosystem.

Activities within the project
This program will target the development of aviation specific standards and protocols around safety, refueling and hydrogen management, enabling rollout of the promising fuel seamlessly. Through European research projects such as TULIPS, the elements of this new infrastructure will be supported with regional expertise. The parties within the program will work together in discussions with potential airline operators for the initial demonstration and subsequent commercial flights, for example with Conscious Aerospace.

Outcome of the project
Delivery of a concept of operations for gaseous hydrogen in airports and demonstration flights to European destinations by the end of 2024, gearing up for commercial passenger flights by 2025 with liquid hydrogen from 2028. The DutcH2 Aviation Hub will also be a national focus to connect with other European hydrogen hubs such as Paris and Hamburg.

Contribution to the regional ecosystem
RTHA’s preparations for being able to fly with hydrogen offer regional parties in the hydrogen ecosystem the opportunity to contribute with technology development and testing to achieve this ambition. RTHA will also soon be able to support regional initiatives in the field of hydrogen flying, such as AeroDelft and Conscious Aerospace, with test and demonstration flights.

Status
The project is already in development with the implementation of several European projects. The accumulated knowledge and hydrogen infrastructure will be available for use by third parties at RTHA.

Finance
To date, funding is provided from European projects and with private funds from the partners in the projects. Additional financial resources are needed to fully scale up with the necessary infrastructure.

Project 12 – Airport Technology Lab (2.0)

New operational processes at airports are becoming increasingly complex, with more safety regulations and more parties involved. A simulated process and data environment, a so-called digital twin, of the airport makes it possible to analyze already at an early research stage what impact new processes will have on the functioning of the airport and whether significant changes in operations are needed.

Prospective partners
- Current consortium partners of ATL, such as Rotterdam The Hague Innovation Airport, Rotterdam The Hague Airport, ADECS Airsystems, Bagchain, Municipality of Rotterdam, SkyEcho, To70, iLabs technologies, WorldStartup, Haagse Hogeschool, MBO Rijnland, TU Delft.
- New partners: for example, another (regional) airport, local (governments), companies (incl. SME's), research and educational institutes, airlines, and airport operators with a focus on digital driven innovation and/or products and services for airports.

Problem the project addresses
Digitization has great potential for airports and the aviation industry to improve operational excellence and customer satisfaction. Utilizing this potential in a regulated environment with strict procedures and strong focus on risk mitigation is a challenge. ATL aims to provide a secure environment for sharing data, test solutions and facilitates a business ecosystem. This ecosystem is rooted in the metropolitan area of Rotterdam and The Hague that seizes the opportunities for (regional) economic development by providing smart digital solutions to solve challenges and improve operational efficiency of airport operations.

Actions taken so far
Since 2019 the consortium of partners within the Airport Technology LAB is working on seizing the opportunity of digitization and use of data for improving airport operations. The consortium led by RHIA and multiple partners, such as RTHA, TU Delft and the Municipality of Rotterdam has successfully realized the fundamentals for a digital driven field lab at RTHA, where airport operations data can be exchanged for innovation purposes, and developed tools, products and services can be tested in an airport environment. Funded by EFRO/ Kansen voor West II, the Airport Technology LAB started as a four-year program, which will run until the end of 2023. After establishing the basic digital field lab infrastructure in the past years, the consortium is exploring further development of ATL after 2023.

Supposed outcome of the project & status
The consortium is working with existing and new partners on a next level Interactive Digital Airport. Goal is to:
- Further develop the (digital) field lab infrastructure.
- Start new innovation projects, focusing on for example:
- Improving co-creation, scenario planning and decision making based on data and digital twin models.
- Increasing the use of data and AI in (autonomous) airport operations for cost-efficiency, new product services, and sustainable airport (ground) operations (incl. emissions and noise).
- Utilizing new technology (like biometrics and scanning techniques) for a seamless passenger journey and agile handling processes.

3. Strengthen the ATL community by involving new partners.

Contribution to the regional ecosystem
The outcome of this activities is a best-in-class interactive digital airport ready for service providers and operators on airside, landside and terminal operations and asset management. By offering an interactive digital airport within a (regional) business ecosystem of innovative and scalable service providers, the region will house a unique development and testing facility. Companies developing their solutions can replicate these at other regional airports. Also, the multi-level research (WO, HBO, MBO) fosters the involvement of students in researching and developing new solutions and creates a better fit between education and the labour market.

Finance
For each of the above-mentioned focus areas there is a coalition of public and private partners that are working on the project development and financing for the period of 2024-2030. Therefore, both regional, national and EU funding opportunities are explored. New potential partners, public, private and SME's, are welcome to explore joining the consortium in one of the projects.

Project 13 – Field lab Next Aviation

The idea of the Field lab Next Aviation started in November 2019 when RTHA became the home of two experimental aircrafts owned by NLR and TU Delft: the two-seater electric aircraft Pipistrel and the research aircraft Cessna Citation PH-LAB. These aircraft will be utilized for testing and demonstration for new sustainable aircraft systems and components.

Prospective Partners
Research institutes, airport, airlines, governments, (new) aircraft manufacturers, energy producers and distributors, regulators, air traffic control, various enterprises active in manufacturing, energy, and operational industries.

Project Description
In the years since, the RHIA community has developed the FNA program by incorporating new partners, starting and linking new projects, and new infrastructure was created at the airport. The aim of this initiative is to provide a testing ground and experimental facilities at an operational airport to validate new forms and components for sustainable aircraft and related operational procedures. A community of partners work together to demonstrate the working of these new aircrafts and procedures at RTHA.

Addressed problem
One of the key challenges for aviation is to reduce emissions (incl. noise). In the aviation sector, it's necessary to validate and certify new types of aircrafts and operations before it's safe enough to take off. With the Field lab Next Aviation, demonstration projects are conducted to test and validate new operational procedures for sustainable aviation. Hereby the next step to commercial, sustainable aviation is closer within reach.

Actions taken
Various actions have been undertaken so far:
- Development and usage of new housing and working facilities at the airport for other organizations to make use of.
- Project funding realized for various related projects such as TULIPS, GENESIS, NEEDED ALBATROS and Smart Rotors.
- Building a network of partners actively involved in realizing the Field lab Next Aviation.
- Communication activities, workshops, work visits and events related to the developments of the mentioned projects.

Supposed outcome
With the project, the following outcomes are aimed for:
- Infrastructure at the airport will be developed to support experiments with hydrogen and electric aircrafts amongst others.
- Housing, research and experimental facilities are available for organizations to be utilized at the airport.
- New sustainable forms of aircrafts and procedures are demonstrated and validated.
- Partners work together in a structural and innovative way in an operational airport environment.

Contribution to the regional ecosystem
The Field lab Next Aviation provides opportunities for new jobs, educational and research activities, and other human capital development. Many of the actors present in the Field lab Next Aviation are located in the region. They contribute to the project in various ways: knowledge, capacity building, infrastructure, funding, and product development. The Field lab Next Aviation also adds value to the region as it's a unique experimental facility at an operational airport.

Status of the project
The initiative has started and has attracted various partners who contribute their expertise. It's currently facilitating the related projects, building the necessary infrastructure, and developing the project for its next phase.

Finance
Various projects are funded by a combination of contributions from the partners involved, regional funding (ERDF) and European funding (Horizon 2020). Additional regional, national, and European funding will be needed for e.g., follow-up current projects, build hydrogen and electric infrastructure, expand housing and experimental facilities at the airport, execute test flights, communications and events and other project related activities.

Project 14 – Test lab Innovative Air Mobility, Advanced Air Mobility and Large Drones/RPAS

Innovative Air Mobility (IAM) / Advanced Air Mobility (AAM) and eVTOL's, the concept of utilizing electric or hybrid-powered aircraft for urban, regional and cargo transportation, holds great potential for transforming the way we transport people and cargo in the future. As we strive towards sustainable and efficient transportation solutions, IAM/AAM presents opportunities for reducing congestion, improving connectivity, and mitigating environmental impacts.

Perspective partners
Province of Zuid-Holland, Unmanned Valley, Port of Rotterdam, High Eye, Volocopter, …

Problem the project addresses
To ensure the safe development of the IAM/AAM and drone sector, testing and robust regulation are crucial to accommodate the growth and establish a safe and coordinated U-space. At this moment we see the authorities struggle to develop the regulations to achieve all these great possibilities. Developing testing protocols and comprehensive regulations in areas such as noise, safety and infrastructure will play a pivotal role in safety standards, building public trust, and further develop the sector.

This project aims to initiate multiple application scenario's for IAM/AAM and larger drones (25-150kg; >150kg) with the goal to determine regulatory requirements. By using Unmanned Valley (required test facilities) for the test operations we can develop data that can be used for

legislation. Not only for the technical requirements, but also for the implementation of larger drones in urban areas by conducting research into the acoustic, visual, ecological and safety components. Thus enable the drone- and IAM/AAM sector to innovate and grow and maximum benefits for society.

Activities in the project
- Determine application scenario's for eVTOL's and large drones and their effects on the U-space.
- Involve all applicable stakeholders.
- Start defining regulatory requirements and necessary legislative actions for the testing of large drones, both pax and cargo.
- Build a regulatory framework for the testing and development of larger drones, pax and cargo.
- Develop and test use cases in collaboration with users (i.e. Port of Rotterdam), drone manufacturers, PZH and Unmanned Valley.

Supposed outcome
- Enable testing of large drones on Unmanned Valley Valkenburg.
- Initiate test use cases in, for example, the Port of Rotterdam.
- Economic advantage for the drone industry, interest from foreign companies to settle here.
- An acceleration of the implementation of drone applications in the society.
- Better understanding of the added value of IAM/AAM to several issues in the society, like quality of living environment, energy transition, accessibility and sustainable mobility.

Contribution to the regional ecosystem
- Supporting drone manufacturing and service companies in developing their technology.
- Further positioning and growth of Unmanned Valley as a key test facility.
- New local business opportunities as well as foreign parties settling in the region.
- Enable regional use cases for IAM/AAM.

Status of the project
Start 2023; Project is under development.

Finance
TBD.

Project 15 – Smart Rotors 2.0

Next to emissions, noise pollution is one of the biggest issues in the aviation industry in the Netherlands. It provides a barrier to further growth of the aviation industry and a potential barrier for further growth in the application of drones in and around urban areas. The Smart Rotors 2.0 aims to build on the knowledge of its predecessor to develop optimal rotors and propellers with minimal noise pollution.

Prospective Partners
KVE, Conscious Aerospace, Saluqi, RHIA, TPY, TU Delft, Inholland, ROC Mondriaan, Maeve

Problem the project addresses
The initial Smart Rotors project has generated valuable knowledge and insights on pathways to reduce emission and noise through the design of propeller and rotor blades which have a significant contribution to noise pollution. Now, hydrogen and battery electric aircraft, drones and eVTOL's allow for different design configurations in, for example, the number and size of rotors for propulsion. This project applies the knowledge and insights from the first Smart Rotors project to develop and test different Fixed Pitch (FP) rotor configurations for electrically powered aircraft, drones and/or eVTOL's to acquire optimal noise reduction and efficiency.

Actions taken within the project
The project will build upon the acquired knowledge from the first Smart Rotors project to develop optimal rotor configurations for electric applications to TRL 6 – 8. It will require the following actions:
- Design and simulation of multiple FP propeller configurations for different electric propulsion systems. In collaboration with the TU Delft, Conscious Aerospace, Maeve and Saluqi
- Development and testing of optimal FP rotor design for optimal efficiency.
- Testing of turbulence and noise of the different FP designs.

Supposed outcome of the project
The consortium aims to realize:
- Further noise reduction to limit disturbance for residents in proximity to airports
- To acquire optimal efficiency for electrical propulsion systems through optimizing FP rotor design
- Build and commercialize IP/knowledge

Contribution to the regional ecosystem
This collaboration between regional aviation companies, startups, knowledge institutions and the regional airport aims to acquire and commercialize valuable knowledge and IP on a global issue for aircraft and eVTOL OEM's. If the project yields significant insights in noise reduction and efficiency optimization through rotor design, the consortium can develop strategically valuable knowledge for OEM's, airports and (regional) governments.

Status of the project
This project will build upon the insights from the first Smart Rotors project. A project plan is currently in development.

Finance
TBD

Project 16 – Circular Thermoplastic Fuselage

Sustainability in aircraft manufacturing and circular product design are becoming more important in the aerospace sector. However, the topic of circular and sustainable materials in aircraft manufacturing is not yet receiving the necessary attention. This project aims to introduce a more sustainable material while reducing total weight of aircraft fuselages by applying a new and innovative design and manufacturing process.

Prospective Partners
KVE, Airbus, Airborne, Toray, TPY, TU Delft, Inholland, ROC Mondriaan, SAM|XL

Problem the project addresses
Currently, mainly aluminum alloys are used to produce aircraft fuselages. However, the use of aluminum alloys has several drawbacks such as its proneness to fatigue, the great amount of energy needed and reducing quality when it is recycled. Thermoplastic composites are seen as potential replacement for fuselages because of its very high strength-to-weight ratio providing lower emissions and superior recyclability. But manufacturing costs are still high. This project aims to demonstrate a patented manufacturing process for the production of thermoplastic fuselage sections that will cut costs and improve throughput times to be able to reduce overall aircraft weight and emissions and improve the use of sustainable materials.

Actions taken within the project
The project is still in early development and aims to develop the technology further from TRL 2 – 3. This will require the following actions:

- Validating the business case for the implementation of thermoplastic fuselages by calculating impact on manufacturing costs, sustainability contributions and effects of foreseen weight reductions. In collaboration with Airbus
- Further development and testing of the press and induction weld process in collaboration with TU Delft
- Development and testing of thermoplastic fuselage sections suited for the manufacturing process together with Airbus and Toray
- Develop an automated production process for the thermoplastic fuselage sections. In collaboration with Airborne.

Supposed outcome of the project
To demonstrate and proof the (economic) feasibility of an innovative manufacturing process for thermoplastic composite aircraft fuselage.

Contribution to the regional ecosystem
To develop this innovative manufacturing process, the knowledge and expertise of multiple regional companies and knowledge institutions will be combined. When the technology is refined and proven it can eventually be implemented and licensed to aircraft OEM's to help the aviation industry become more sustainable and provide a strong business for consortium partners.

Status of the project
The project is in early development.

Finance
TBD

Project 17 – Bio-based composites for Circular Aircraft

The aerospace industry is facing increasing pressure to reduce its environmental impact and transition to more sustainable practices. A promising area to introduce more sustainable products is bio-based composites. This research project will focus on developing an efficient design and manufacturing process to produce aerospace grade bio-based composite materials.

Prospective Partners
Eve Reverse, Airborne, TU Delft, Inholland, Avantium, Plantics, Universiteit Wageningen, NPSP, Bambooder, Duplico, Cato Composites, Total/Corbion

Problem the project addresses
The increase of carbon fiber composite materials helps in the use of lighter weight products, resulting in emission reductions. The manufacturing of carbon fiber composite products still requires large amounts of energy and thus CO2 emission. A promising area of improvement is bio-based composites made from renewable (carbon) materials such as plant fibers and resins derived from natural sources. By going a step further in innovative design and manufacturing processes, bio-based composite products can be much less carbon-intensive, and ultimately even carbon-negative. A cross-sectoral consortium will be build that combines the knowledge of aerospace manufacturing, bio-based material science and chemistry, based in Zuid-Holland. While looking at the complete Life Cycle Assessments (LCA) of products, research will be conducted to develop an efficient design and manufacturing route from natural fibers and polymers to high performance bio-based composites for circular aviation products. Although in an early stage (TRL 2 – 3), these circular materials replace existing petroleum-based composites in, for example, aircraft cabin interiors such as seats, overhead bins, flooring, and insulation. But they also have the potential to be used in structural parts.

Actions taken within the project
Bio-based composites are still in early development (TRL 2/3). These steps will be taken in this R&D project:

- Build and coordinate a cross-sectoral consortium of startups, companies and knowledge institutions on bio-based composites for aerospace applications.
- Stimulate and promote a national program for bio-based composites.
- Conduct research on manufacturing technology for natural (carbon) fiber bio-based composites.

Supposed outcome of the project
Building a competitive (inter)national cluster for bio-based composites. The consortium will support the development of the technology from TRL 2/3 to TRL 4/5. The technology would

eventually enable aircraft manufacturers and suppliers to produce carbon-negative products and improve sustainability in aviation.

Contribution to the regional ecosystem
The Netherlands (and the region) has always been on the forefront of composites and composite manufacturing for aviation and space applications. With sustainability as major priority, the partners in this project have the goal to build to a competitive bio-based composite cluster.

Status of the project
The project is in early development.

Finance
TBD

Project 18 – Advanced electrical wiring Interconnection Systems

In the Electrical and Thermal Systems for Sustainable Powertrains initiative, a consortium of Dutch companies, knowledge institutes and international partners is working to develop the new electrical and thermal systems crucial for future sustainable aircraft. This project is part of the Luchtvaart in Transitie program.

Partners
ADSE, Habia Cable, plc-tec, 3D Value, TU/e, Universiteit Twente, TU Delft, NLR, Komax, TNO, ParaPy, KE-works, Signify, MDE Automation, GKN Fokker

Problem the project addresses
Sustainable aviation requires different energy carriers and propulsion systems. Conventional powertrains will be replaced by (hybrid) electric powertrains. This is only possible if new advanced electric wiring interconnection systems (EWIS) are developed. That requires new knowledge, technologies, and products to distribute high power safely and with limited added weight to the system.

Expected outcome
Demonstrators of high-voltage cabling systems on relevant demonstration aircraft platforms, selection of most promising disruptive technologies for data transmission and automation solutions for both design and production processes of electrical wiring systems will take place in 2026.

Fundamental knowledge development projects are started, for example in the field of electrical, thermal and electromagnetic behavior of future electrical cabling systems.

Contribution to the regional ecosystem
The project's packages will be mainly carried out at the GKN Multi Technology Center within the region, in close collaboration with (regional) partners. IP on EWIS and associated processes will be developed in the region which will strengthen the strategic value of the partners in the consortium.

Project 19 – SCN AVATAR (continuation)

SCN Avatar is a Dutch innovation centre focusing on the use and the development of virtual and augmented reality applications for the space sector. In this centre, different parties can be built on their existing know-how through cooperation to come-up with novel solutions using Virtual and Augmented Reality that the future space environment demands.

Prospective partners
ATG Europe, RHEA Systems, NLR, TU Delft, Radboud Radiolab. This group of partners will be expanded with companies and institutes from the space domain mostly.

Problem the project addresses
High tech sectors, such as the aerospace domain, are typically characterised by high levels of technical complexity characterized by geographical distributed supply chains to execute large development programmes. Recent trends and unexpected events are leading to lower risks (and cost) associated with this complexity more urgent. SCN AVATAR aims to develop solutions to tackle these challenges through the use of Virtual and Augmented Reality. As a foundation, consisting of both industrial and institutional parties, it can leverage on a wealth of knowledge and expertise on various aspects of immersive technologies from the partners as well as on access to market.

Activities within the project
Specific areas of development are determined jointly by the parties involved in the centre;

- Assembly Integration and Testing: training and assisting the assembly process of complex systems, the integration and the testing of components and complex systems;
- Engineering process optimisation: the improvement of the full engineering cycle of different subsystems, ranging from communication and review through virtual models to design and prototyping in virtual or augmented reality;
- Large data set visualisation and VR/AR driven Earth Observation, Navigation (and other space-related data) applications
- Remote handling, human-machine interfacing and environmental training of, for example, robots and other machines

Supposed outcome
SCN AVATAR aims to implement different immersive reality solutions that not only bring added value but can create an immersive ecosystem that allows users to move seamlessly from one reality to another throughout the project lifecycle, maximizing the added value with optimal interfaces.

Contribution to the regional ecosystem
The centre offers (regional) companies and institutes the infrastructure for R&D of services, tools and their application as well as the knowledge base for the projects, facilitate marketing, business development and the commercialization of technologies. It also facilitates knowledge and IP development within the region and, located on the NL Space Campus, it is directly linked to the local and international space ecosystem.

Status
SCN Avatar has been active since 2020 and will continue until at least the end of 2025.

Finance
SCN Avatar is currently funded through co-investments from participating parties, co-finance from the province and the national government (through development projects). The intention is to find additional (co)funding to continue the project.

Project 20 – Composite Launcher Structures

As society we increasingly depend on satellite services to, for example, battle climate change, provide communication and data transfer, and provide (inter)national safety. The demand for satellites is growing rapidly while the costs of satellites and their launches are decreasing. To bring these satellites into orbit, launch capacity has to grow. The trends is moving towards small launchers that can offer affordable missions to bring satellites in orbit. Such launches are enabled using launch structures which must be lightweight but still capable of carrying heavy and complex loads.

Prospective Partners
Airbus Netherlands, NLR, ATG, GTM, Airborne, TU Delft

Problem the project addresses
To strengthen the regions global competitive position in a key area of expertise, Airbus NL will develop and apply new advanced composite materials in launcher structures. As most current launcher structures are built from metals, a transition towards Carbon Fiber Reinforced Plastics (CFRP) structures will reduce the weight and prevent waste materials and reduce design costs, as well as bring down recurring cost for CFRP structures to a competitive level. The present development is at TRL-6 (prototype level) but needs to be fully qualified and industrialized. In parallel, reusability of the (composite) launch structures will also be explored.

Presently, the position of the Netherlands in the European launchers is becoming uncertain due to limitations in the budget available to support this element of the national space policy. At the same time the Netherlands fully supports the principle of European independent access to space, which is directly linked to our national strategic autonomy. A collaborative project to develop composite launcher structures for EU launchers will allow the Netherlands to continue its contribution to this important European and national domain.

Actions taken within the project
- Build a consortium or coalition of (regional) partners for long term development.
- Define (technical) requirements for the development and testing of CFRP on a material level.
- In parallel, develop a scalable production process for industrialization.
- Explore the application of Simulation Driven Product Development to optimize development costs and lead times.

Supposed outcome of the project
By developing and industrializing composite launcher structures, the project aims to reduce cost of access to space and improve sustainability by reducing waste in production, as well as focusing on reusability of future launcher structures.

Contribution to the regional ecosystem
A consortium of (regional) partners will help develop new knowledge and technology in a key area of expertise within the region (composites) and thus boost the overall competitive position of the Aerospace Delta cluster.

Status of the project
Currently in development.

Finance
Funding is needed for development up to the level of a first product including industrialization and a related manufacturing infrastructure.

Project 21 – Smart production & assembly of solar arrays

As the demand for small satellite constellations continues to soar, the need for efficient and scalable production of solar arrays for such satellites has become paramount. A consortium of companies will initiate an industrialization project by developing a prototype Smart Production Facility which aims to boost the (price)competitiveness of the regional high-tech manufacturing industry.

Prospective Partners
Airbus Netherlands, Airborne, GTM, Inholland/Haagse Hogeschool Delft, LiS, SAM|XL, Ground support equipment partners

Problem the project addresses
Current challenges lie in the lack of flexibility and scalability of the production process, hindering the industry’s ability to meet the growing market demand and constantly changing product and process requirement. The goal of this project is to enhance production from single piece flow to First Time Right batch or series production from 20 to 500 units per year by exploring and testing Smart Manufacturing technologies such as advanced robotics, AI for quality control and digital manufacturing for increased flexibility and supply chain collaboration.

Actions taken within the project
- Determine the business case for multiple industrialization scenario’s based on scaling and flexibility requirements.
- Define key bottlenecks in scalability and flexibility such as the automation of the production of substrates and quality control/inspection processes
- Investigate production technologies for new carrier systems for a range of solar cell networks
- Explore and determine applicable industry 4.0 technologies to tackle industrialization challenges

Supposed outcome of the project
Combining the knowledge and technology of partners in the Zuid-Holland region and Airbus NL, further strengthen the leading position as manufacturer of solar arrays for space applications. This will be established through the development and testing of a prototype to implement a super-efficient, flexible production line.

Contribution to the regional ecosystem
The prototype production line will bolster the region's position to contribute to the booming demand for satellite constellations, while using knowledge and expertise in industry 4.0 of regional partners and companies.

Status of the project
Currently in development.

Finance
TBD

Project 22 – ATG CompositesLab: Aircraft Rib & Drone Fuselage

ATG CompositesLab is an in-house engineering team of ATG Europe focusing on developing innovative composite structural solutions, including a patented one-shot manufacturing process for ultra-lightweight grid-stiffened & lattice composite structures. This technology is currently being developed toward TRL6 through European Space Agency (ESA) funded programs for large primary structure spacecraft applications such as satellite central tubes, launcher interstages and satellite dispensers among others. Other potential applications for the technology include components in the aviation industry, specifically aircraft ribs and drone fuselages.

Prospective partners
ATG Europe, Airborne, NLR, TU Delft. This group of partners will be expanded to companies and institutes from the composite materials and aviation domains mostly.

Problem the project(s) address(es)
There are 2 projects currently in development within the ATG Composites: the Lattice Aircraft Rib and the Grid-Stiffened Drone Fuselage.

The Lattice Aircraft Rib: Aircraft rib design is still typically an aluminum structure that involves multiple components and processes including machining, forming, cutting, bonding and fastening to create an end product. This is highly intensive and involves a lot of material wastage to achieve the final design. Implementing ATG's composite lattice technology for aircraft ribs would provide multiple benefits including the ability to tailor structural architecture to optimize design, significant weight savings, facilitating access for assembly, maintenance etc., one-shot manufacturing process and associated cost reductions.

Grid-stiffened Drone Fuselage: given the characteristics of the grid-stiffened technology, it can be applied to fuselage structures in absence of internal pressurization, making large drones a good candidate. While drone operators are in search for lighter structures to reduce fuel consumption and increase payloads, the cargo drones sector in particular is considered a promising field of application for ATG Europe's technology. Implementing ATG CompositesLab's composite grid-stiffened technology for drone fuselages would provide multiple benefits including the integration as a whole fuselage section allowing for a decrease in cost and mass, the lower end-product price increases competitiveness and enables a higher payload mass. And the key differentiators of the technology reside in its very high specific stiffness, its design flexibility, its one-shot manufacturing process reducing lead times and the low complexity of its attachment zones.

Activities within the projects
The Lattice Aircraft Rib: specific areas of development include:
- Design of a lattice aircraft rib: obtaining requirements for aircraft ribs including loads, manufacturing and assembly tolerances, system integration and others.
- Manufacturing of a full-scale demonstrator.
- Assembly Integration: design, manufacture and assembly of representative surrounding structure.
- Testing: design of test configuration including test rig, MGSE and actuators.

Grid-stiffened Drone Fuselage: the first steps towards industrial application are closing the remaining technical gaps:
- Detailing and testing the manufacturing method for an irregular shape double curved part.
- Determining the sensitivity of grid-stiffened structures to fatigue.
- Developing an efficient repair approach and method.
- Develop processes and procedures in order to manufacture a full-scale demonstrator.

Supposed outcome
The Lattice Aircraft Rib: Successfully manufacturing and testing a full-scale lattice aircraft rib using representative design loads would advance the technology to TRL 4/5 and confirm the viability of the lattice technology for this application. In addition, a prototype lattice aircraft rib could be produced which could be integrated into a wing-box assembly by a viable end user / potential customer.

Grid-stiffened Drone Fuselage: Confirm the viability of grid-stiffened cargo drone fuselage structures through the successful production and inspection of an irregularly shaped double curved part. Verify the quality of the part and assess its ability to withstand impact damage. Validate the developed repair strategies and define processes and procedures to carry out repairs during manufacture and operation.

Contribution to the regional ecosystem
The design, analysis, manufacture and testing of a full-scale lattice rib and grid-stiffened large cargo drone fuselage could be conducted through existing companies / institutions in the region. If the use of the technologies were deemed to be viable applications, this could result in significant manufacturing and associated employment for the region considering the forecasted demand for large commercial aircraft and drone market volumes in the coming 20 years.

Status

ATG Europe has been operating for 50 years providing engineering and technological solutions to Agencies & industrial organizations and for the past decade has had its own internal engineering department, which includes ATG CompositesLab. ATG CompositesLab currently has multiple projects running with both institutional and new space customers with a view to advancing the lattice and grid-stiffened technology and securing flight heritage for at least one of the associated applications in the next 1-2 years.

Finance

ATG CompositesLab is funded through internal investment and via funding through ESA programs such as the Core Technology Program (CTP), the General Support Technology Program (GSTP) and the Future Launcher Preparatory Program (FLPP). The intention is to find additional (co)funding outside of the ESA funding mechanisms, specifically to support terrestrial applications of the lattice technology.

Partners of the Aerospace Delta