

FINAL

Development of the Scottish Space Industry

EXECUTIVE SUMMARY

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Executive Summary

Introduction

Scotland's history as an innovative, scientifically and technologically advanced country is strong and illustrious. Indeed, Scotland's space industry is significant, and it leads the line globally in the nascent field of nanosatellites (particularly CubeSats). The Scottish space industry covers activities across the value chain, including leading space science research institutes, internationally recognised satellite platform primes, satellite operators, leading applications developers at the European level and commercial users of a wide range of satellite signals.

However, there is room to grow Scotland's space industry in line with the rest of the UK, which has set ambitious growth targets out to 2030. This report, commissioned by Scottish Enterprise, is a step towards realising the Scottish space industry's potential.

Objectives of this study

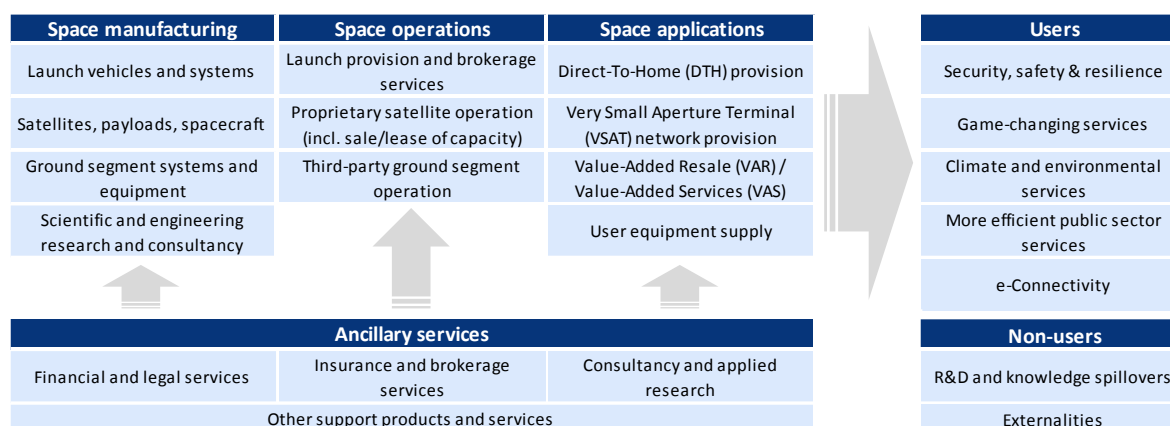
The objective of this report is to answer two overarching questions:

- 1) Where is the Scottish space economy at present: in an absolute sense; and in comparison to the UK and global space economy?
- 2) Where could, and should, the Scottish space economy, and its composite segments, reach in the medium-term (2020) and long-term (2030)?

Where is the Scottish space economy at present?

The traditional view of the space sector has focused on the space industry in isolation – companies that manufacture, launch and operate space assets (e.g. satellites), but a more modern view is to extend the definition to include companies that utilise the signals and data supplied by these space assets to develop value-added applications (e.g. earth observation imagery, satellite broadband services, etc.). This expanded group of companies is referred to as the **space economy**.

The value chain segmentation presented below comes from *The Case for Space 2015* and is adopted for the purposes of this report.



Source: *London Economics*

Each segment is described briefly on the subsequent pages.

Scottish organisations in the global supply chain

Space manufacturing

'Space manufacturing' involves the assembly of complete spacecraft, subsystems and components, launchers and the necessary terrestrial infrastructure (e.g. ground stations). The supply chain for space manufacturing is further broken down into five separate groups of entities (some of which are vertically integrated):

- **Primes** are the last link in the chain of delivery of space products to government or commercial customers. Their work involves assembly of final spacecraft, launchers or ground infrastructure.
- ✚ The most prominent Scottish prime is Clyde Space.
- **Tier 1** companies design and assemble major sub-systems such as power supply, communications, propulsion etc., which are sold to primes for final integration.
- ✚ Major Scottish companies in Tier 1 include Clyde Space, Com Dev (through subsidiary MESL Microwave), the UK Astronomy Technology Centre, and Bright Ascension.
- **Tier 2** organisations manufacture equipment to be integrated in major sub-systems. Many tier 2 organisations also act as central parts procurement agents acting as middle-men in the procurement of components from lower tiers.
- ✚ Scottish Tier 2 companies include AGM Batteries, Com Dev (through subsidiary MESL Microwave) and Selex.
- **Tiers 3 and 4** firms include producers of components and sub-assemblies such as cables and electronic, electrical and electromechanical (EEE) components.
- ✚ Scottish organisations include STAR-Dundee and Axon' Cable.
- **Other suppliers** including raw materials (e.g. sheet metal) and other more generalist suppliers (e.g. off-the-shelf software and components).

Space operations

'Space operations' is the operation of space and ground infrastructure for the purpose of generation and terrestrial distribution of satellite data. The main inputs into the business of space operations are outputs from space manufacturing (space- and ground-based infrastructure), supplemented by software (from ancillary service providers) and off-the-shelf products.

- ✚ Scottish space operations firms include Harris CapRock UK, NEODAAS, Spire Global and Veripos.

Space applications

'Space applications' comprises commercial organisations using space signals to offer value-added services to consumer end-users. Broadly, there are three types of space applications firms:

- 1) Firms that add value to space signals, such as Earth Observation imagery, which can be used to monitor various environmental parameters;
 - ✚ Scottish companies include Astrosat (previously known as Stevenson Astrosat), Global Surface Intelligence and Ecometrica;
- 2) Companies that sell access to space signals, such as direct-to-home broadcasts, satellite communications (including broadband internet services) and navigation;

✠ Scottish firms include Sky, Harris CapRock and Apogee Internet;

3) Companies that manufacture or retail the equipment required to access space signals.

✠ Scottish entities include Caledonian Airborne Systems, Harris CapRock, and Veripos.

The supply chain to types 1 and 2 primarily consists of data from space operations companies, software (from ancillary service providers) and off-the-shelf products (such as IT), while type 3-companies require various inputs similar to tiers 3 and 4 in space manufacturing (i.e. EEE, cables etc.). User equipment (type 3) is a necessity for companies in type 2.

Ancillary services

'Ancillary services' refer to specialist support activities (e.g. consultancy, software) catering to the specific needs of space organisations throughout the space value chain segments listed above.

✠ Scottish organisations include PHS Space, Ecometrica, and Astrosat.

Scottish space economy in a UK and global context

The **global space economy** is valued (turnover) at between **£155 billion and £190 billion** (OECD and Space Foundation, respectively), with the **UK** accounting for **£11.8 billion** (£5.0 billion excluding Direct-To-Home satellite broadcasting), equivalent to a share of between 6.3% and 7.7%.

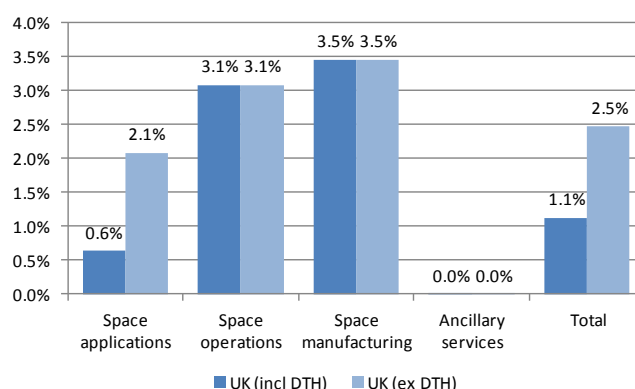
Estimates of global employment in the space economy are hampered by lack of reliable data, but based on estimates from OECD (2014) *The Space Economy at a Glance* and Space Foundation (2015) *The Space Report 2015*, global space employment is estimated in the order of 890,000 full-time equivalents, but the estimate is highly uncertain.

Scottish space turnover has been estimated to be **£134.1m** in 2012/13, but unlike UK and global totals, Scotland's focus in terms of the space value chain is further upstream. The table compares Scottish, UK and global shares, with UK and global shares further broken down by inclusion and exclusion of DTH.

Turnover distribution across Value Chain	Space manufacturing	Space operations	Space applications	Ancillary services
Scotland	23%	33%	44%	0%
UK (incl. DTH)	8%	12%	78%	2%
UK (ex DTH)	17%	27%	52%	4%
Global (incl. DTH)	33%	8%	58%	0%
Global (ex DTH)	41%	10%	48%	0%

Source: London Economics (2015) *The Case for Space 2015*; OECD (2014) *The Space Economy at a Glance*

Scotland's share of UK total turnover by value chain segment reflects this different focus, and the country's share of UK space manufacturing and space operations is therefore greater than its overall total while space applications (both including and excluding DTH) is smaller. Ancillary services in Scotland are significantly less valuable than the UK total. The figure summarises.



Source: London Economics (2015) *The Case for Space 2015*

Where could, and should, the Scottish space economy reach?

To inform an answer to this question of the maximum growth potential for the Scottish space economy, we undertook the following analyses:

- Drivers of the global space industry and emerging market needs;
- Lessons from existing location-based space clusters;
- SWOT analysis;
- Potential benefits of a spaceport;

Drivers of the global space industry and emerging market needs

The global space economy is changing, and the Scottish space economy is well-placed to capitalise on some of these changes:

- **Increasing commercialisation of space:** As measured by the Space Report,¹ the share of economic activity in the space economy that satisfies government demand has reduced from 33% in 2009 to 24% in 2014, with the residual comprising private sector demand.
- **New Space movement:** ‘New Space’ is a philosophy or movement that characterises a new breed of privately funded space organisations defined by principles such as: low-cost, clean sheet design, highly innovative and commercially-driven. This nascent, but rapidly growing, global community of entrepreneurs and organisations are challenging the established approaches to space development of the traditional mainstream space industry.
- **New Space Age:** Thanks to decades of investment in R&D, exploration and infrastructure development, we are entering a ‘New Space Age’ – the age of applications. The relationship of the average citizen or company with space has changed more in the last decade than in the previous four.
- **Internationalisation of space value chains:** The combination of limited government budgets and the high cost of space exploration have led public space agencies down the road of collaboration; and to great effect (e.g. International Space Station). Meanwhile, as in other economic sectors, space organisations have needed to adapt to globalisation and ensure its success in the face of competition from the rest of the world.
- **Internet of everything and everywhere:** In the future, the Internet-of-Things will become the Internet-of-Everything – with rapid growth forecasted over the coming decade. To create value, ‘things’ will need constant connectivity, and satellite communications remain a unique technological option. The value added will also be boosted if the ‘thing’ knows where it is, so it is reasonable to expect many devices to be equipped with satellite positioning (GNSS) capability.
- **Small Satellite revolution:** With payload weight positively determining the cost of space access, combined with the continuing miniaturisation of technology, there is a clear trend towards small satellites. Smaller satellites are becoming especially relevant with the constellations envisaged for Low Earth Orbit (or lower) that can provide remote sensing, satellite broadband and many innovative new services in the future.

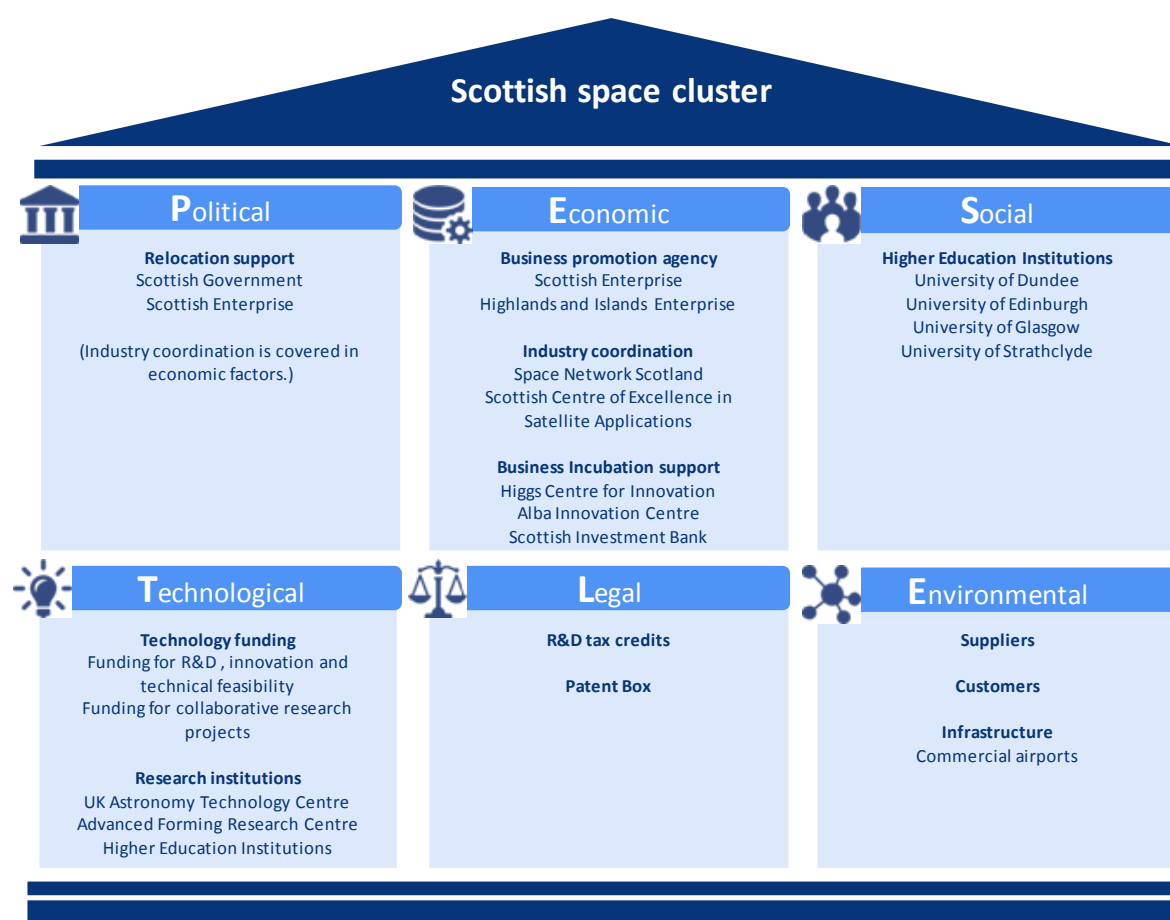
¹ Space Foundation (2015) *The Space Report 2015*

Lessons from existing location-based space clusters

Scotland may be regarded as a location-based space cluster. In order to inform and guide the development of the Scottish cluster to become competitive, and ultimately world-leading, it is insightful to examine the successful existing space clusters. The framework chosen was PESTLE analysis, which assesses the Political, Economic, Social, Technological, Legal and Environmental factors supporting the clusters.

The Scottish space cluster is supported by a range of institutions, policy measures and other infrastructure characteristics, backing the industry by means of a range of activities including networking and industry coordination, business incubation, technology funding, business and industry promotion, and research and education activities.

The PESTLE analysis of the Scottish space cluster is provided below.



Source: London Economics' analysis

The same analysis was applied to three world-leading location-based space clusters (Bavaria, Colorado and Harwell) to identify gaps. The identified Key Success Factors (KSFs) and implications for Scotland are presented in the following table:

Key Success Factor (KSF)	Bavaria	Colorado	Harwell	Scotland	Comments	
Scale	Companies	550 ¹	160 ¹	60 ²	128 ²	
	Employees	36,000 ¹	25,000 ¹	5,000 ³	>814 ²	
Political	✓	✓	✓	(✓)	<p>Relocation support: Relocation grant funding provided by Scottish Government, Scottish Enterprise (e.g. to Spire) and Highlands & Islands Enterprise.</p> <p>Industry coordination: Governments in Colorado and Bavaria operate policy programmes aimed at coordinating and connecting the respective space clusters. In Scotland, such coordination activities are instead supported by Space Network Scotland (a Scottish Enterprise project) and the Scottish Centre of Excellence for Satellite Applications (see economic factors).</p> <p>National Space Agency: DLR in Bavaria undertakes research and provides business incubation support. In Scotland, these activities are covered by range of other organisations (see economic and technological factors), without a physical presence of the UK Space Agency.</p>	
Economic	✓	✓	✓	(✓)	<p>Business promotion: Scottish space industry is supported by Scottish Enterprise, Highlands and Islands Enterprise, and Scottish Development International.</p> <p>Business incubation: To be provided by the Higgs Centre for Innovation, to be launched in 2016, with plans currently at a relatively small scale. Additional support is provided by the Scottish Investment Bank, the Alba Innovation Centre, and ESA's Integrated Applications Promotion Ambassador Platform for Offshore Energy.</p> <p>Industry coordination: Undertaken by Space Network Scotland and the Scottish Centre of Excellence in Space Applications. Both organisations launched only relatively recently, with activities currently only in beginning stages and at relatively small scale.</p>	
Social	✓	✓	✓	✓	Key Higher Education Institutions include the Universities of Edinburgh, Glasgow, Strathclyde and Dundee.	
Technological	✓	✓	✓	✓	<p>Research institutions: Scottish universities (with space-related research departments), the UK ATC and the Advanced Forming Research Centre.</p> <p>Technology funding: Provided by the Scottish Investment Bank and Scottish Funding Council, and at UK and European Union level. Grants at Scottish level are relatively small, and could be pooled into single funding strand to facilitate funding access for SMEs.</p>	
Legal		✓	✓	✓	<p>Scotland: Tax advantages (R&D tax credits (tax deductions for R&D expenditure) and Patent Box (tax deductions for profits derived from UK-owned IP). Also applies to Harwell.</p> <p>Colorado: Tax advantages (tax exemptions for personal property related to space and simplified corporate income tax structure) and targeted legislation (to support potential Spaceport Colorado).</p>	
Environmental	✓	✓	✓	(✓)	<p>Suppliers: Scotland's supply chain is generally strong, but the lack of a satellite operator (changed by Spire) means space applications firms currently source inputs abroad.</p> <p>Customers: With the location of Spire's European headquarters, the customer side is well-developed.</p> <p>Infrastructure: Scottish businesses are relatively less well connected than those in Colorado, Bavaria and Harwell, with smaller airports and fewer international connections available. Bavarian industry further benefits from Special Airport Oberpfaffenhofen.</p>	

Note: ¹ Refers to number of companies and employees associated with the entire *aerospace* industry in the relevant location, not just the space sector itself. ² Refers to number of companies and employees associated with the space industry. ³: 5,000 employees across 200 organisations in Harwell, no separate estimate for the space companies exists. **Source: London Economics' analysis**

In order for Scotland to become a *market-leading* space cluster, a **strategic focus** on one capability, market or infrastructure needs to be identified and all development effort need to be focussed on establishing Scotland as a global authority and centre for that activity.

Cautionary note: In the case of a strategic focus, it is imperative to first consolidate and maintain the strong existing base of the Scottish space industry and economy – so as not to demote the importance of these organisations, nor to ‘put all the eggs in one basket’.

SWOT analysis

The matrix below summarises the results of an analysis of the Scottish space industry’s Strengths, Weaknesses, Opportunities and Threats (SWOT) – for the full discussion, please see the Full Report.

<p style="text-align: center;">STRENGTHS</p> <ul style="list-style-type: none"> ▪ Small satellites supplies ▪ CubeSat development and manufacture ▪ New Space companies ▪ Business promotion activity by the development agencies ▪ FDI location and relocation support to attract foreign companies ▪ Tax advantage ▪ Grant funding from the Scottish Government and the development agencies ▪ Existing ground segment operators (teleports & EO) ▪ Proximity to customers in the Oil & Gas sector ▪ Presence of higher education and research institutions (e.g. UK ATC) ▪ Part of a dynamic and growing UK and European space economy ▪ Work/life balance and quality of life in Scotland 	<p style="text-align: center;">WEAKNESSES</p> <ul style="list-style-type: none"> ▪ Few OEMs ▪ No traditional space primes/system integrators ▪ No critical mass/limited scale of the industry ▪ Underdeveloped space applications ▪ No satellite operators, but due to change (Spire) ▪ Space-specific incubation support, but due to change ▪ Networking between companies (B2B) and research institutions ▪ Connection to Europe and rest of the world
<p style="text-align: center;">OPPORTUNITIES</p> <ul style="list-style-type: none"> ▪ Attraction of the UK spaceport ▪ UKSA expanding to Scottish location ▪ InnovateUK and/or UKSA funds ▪ Continued growth of CubeSats ▪ Continued, growing, importance of New Space ▪ FDI relocation funding for satellite operators (e.g. Spire) ▪ Space applications development ▪ Cluster policy ▪ Small Satellite Revolution 	<p style="text-align: center;">THREATS</p> <ul style="list-style-type: none"> • Failure of demonstrator projects (Clyde Space and/or Spire) • Competition from cheaper ‘copy-cat’ CubeSats and PocketSats • Insufficient engineering/programming and marketing skills • Neglect of space applications • Negative regulatory shocks • Uncertainty surrounding EU referendum • Reduced UK-level funding • Reduced public funds/support

Source: London Economics analysis

Potential benefits of a spaceport

Note: This section presents generic benefits based on published secondary sources and makes neither commentary nor any recommendation on the most suitable location for a UK spaceport.

All else equal, the UK Government’s commitment to building a spaceport in the UK by 2018 will facilitate easier access to space for UK and Scottish companies, by reducing logistical challenges. For this reason, the analysis of the benefits of a potential spaceport is separated in two:

- Benefits of a UK spaceport (‘generic’ benefits of proximity); and
- Benefits of a spaceport in Scotland (local economy benefits).

Benefits of proximity to a UK spaceport

Irrespective of whether the UK spaceport is ultimately located in Scotland, England or Wales, the closer proximity to a launch facility will make the logistics of launch significantly easier. This will reduce the need to ‘piggy-back’ off larger satellites launches into geostationary orbit. The main drawback of the piggy-back launch model is that the smaller satellites are always secondary to the main satellite, often resulting in difficulties with orbital transfer and scheduling.

The reduced cost and complexity resulting from a local launch facility dedicated to sub-orbital launch will improve the commercial offering of British companies, thanks to better certainty on launch dates and lower costs. The associated risk-reduction stemming from closer control of the supply chain will also lower the cost of doing business for British companies in the space operations and applications value chain segments. For this reason, the industrial activity is expected to increase.

Local economy benefits of a spaceport

The location ultimately chosen as the site of the UK spaceport will experience a range of local economy benefits arising from:

- **Spaceport operations** – Generation of Gross Value-Added and employment creation by the spaceport operator and sub-orbital commercial spaceflight and/or satellite launch service provider (direct effect). The supply of goods and services to the construction and operation of the spaceport will support activity for suppliers (indirect effect), whilst employees will spend their disposable income in the local economy, supporting other businesses in the region (induced effect);
- **Space-related tourism** – Spending by spaceport visitors and staff in the region, other tourists in the region visiting the spaceport, and spending on other tourist attractions.²
- **Space-related education** – Increased research and development fostered by the presence of a spaceport, and access to space.

Using the reported baseline cumulative values in 2028, range estimates for 2020 and 2030 have been calculated for the total estimated benefits to a local economy of a spaceport, and by activity.

Activity	Economic activity		Employment	
	2020	2030	2020	2030
Operations	£5m - £8m	£60m - £90m	30 – 50	400 - 450
Tourism	<£1m	£3m - £5m	5 - 15	90 - 110
Education	<£0.1m	<£0.5m	<1	<5
Total	£5m - £9m	£60m - £100m	35 - 65	490 - 550

Note: Calculations are based on cumulative figures for 2028. Assuming a line of best-fit is used to estimate values for 2020 and 2030

Source: London Economics’ calculations based on ‘Spaceport UK: Forging ahead with commercial confidence’ report

Additionally, the establishment of a spaceport could attract Foreign Direct Investment (FDI) to the region for structures such as: a visitor centre; R&D facilities; a bespoke hangar space and maintenance; shops and restaurants within terminal facilities; and a conference centre for events.

² For the purpose of this study, spending on other tourist attractions is excluded from the analysis as only space-related activities is of interest. Hence, only two-thirds of the total reported baseline economic activity and employment for space-related tourism is used.

Maximum growth potential for the Scottish space industry

The UK's Space Innovation and Growth (IGS) Action Plan from 2010 defines a target for the UK space economy to capture 10% of the global market by 2030,³ which has been estimated to equate to £40bn of economic activity. The Space IGS also includes an interim target in 2020 of 8% of the global market, estimated to amount to £19bn.

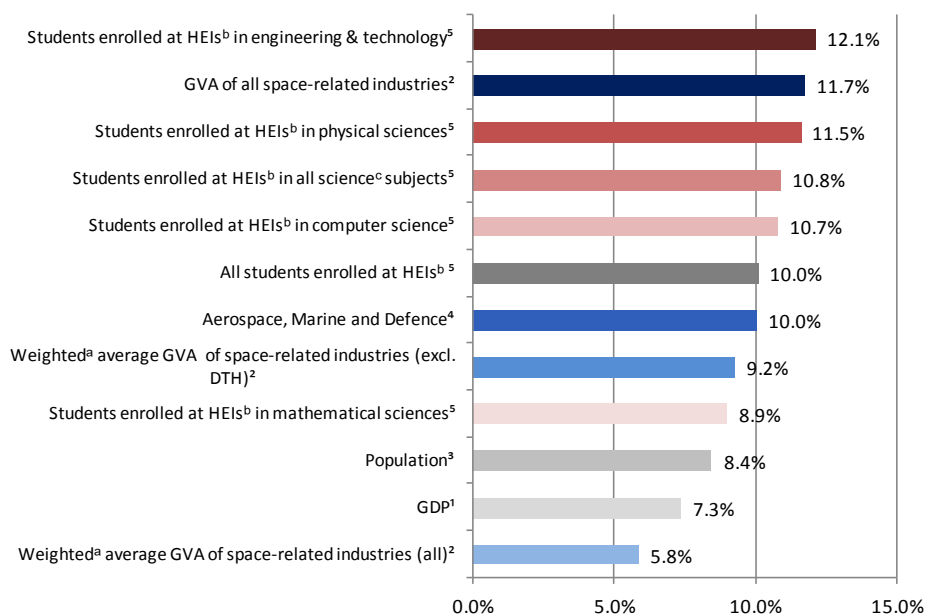
It is recognised that in order for the UK achieve its target, all countries and regions need to pull in the same direction, and only with combined effort can the target be met. This section presents a suggested, equivalent number for Scotland.

Medium-term potential (2020)

From Scotland's current share of the UK space economy of 1.1% (2012/13), it is suggested that a reasonable target is to achieve **3%** of the UK total by 2020. The elaboration of this interim target (please see the full report) takes into account that the policies to be implemented between now and then will need time to take full effect.

Long-term potential (2030)

The long-term potential is not governed by the current size and shape of the space economy, and all parameters may change over the period. It is therefore informative to consider Scotland's share of economic indicators to inform the estimate. The figure below presents the most recent Scottish shares of UK totals, which are discussed afterwards.



Notes: ^a: Weighted by total UK space GVA; ^b: HEIs: Higher Education Institutions; ^c: Medicine & dentistry, Subjects allied to medicine, Biological sciences, Veterinary science, Agriculture & related subjects, Physical sciences, Mathematical sciences, Computer science, Engineering & technology, and Architecture, building & planning

Sources: ¹: UK IO tables and Scotstat IO tables (2010); ²: UK IO tables and Scotstat IO tables (2010), C4S; ³: 2011 censuses in Scotland, England and Wales, and Northern Ireland; ⁴: Scottish Development International <http://www.sdi.co.uk/>; ⁵: Higher Education Statistics Agency (2015). 'HESA SFR 210: Higher Education student enrolments and qualifications obtained at higher education providers in the United Kingdom 2013/14'.

³ UK Space Innovation and Growth Strategy (2015) 2015 Update Report available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/444918/SPACE-IGS_report-web-JJF-V2.0.pdf

Scotland's share of gross value added in the economic sectors that constitute the space economy⁴ amounts to 5.8% when DTH is included and the sectors are weighted by space-related GVA. However, DTH is near saturation in the UK, and the space economy growth that is required to achieve the UK's targets needs to be driven by other space activities. Considering GVA of non-DTH sectors, Scotland currently accounts for 9.2% (still weighted by space-related GVA in the sector). As these sectors are strong candidates for delivering the growth required in the UK, the current Scottish proportion can be considered an indicator of what can be achieved outside DTH if the relative size of the sectors remains constant.

DTH will, however, remain a significant space application, and its continued importance means the overall achievable value is likely lower than 9.2%.

Scotland's share of unweighted GVA in the sectors that constitute the space economy is 11.7%. Hence, Scotland could benefit from a change of focus among fringe space economy organisations.

In combination, Scotland's success at attracting students for space-relevant university studies, and the fact that 78% of Scottish graduates have been found to remain in Scotland after graduation suggest that Scottish space organisations will be able to attract and retain qualified staff at a slightly better rate than the 9.2% of the UK.

In summary, Scotland's achievable share of the UK space economy by 2030 is suggested to be **9%** excluding activity expected in the case Scotland is selected to host the UK spaceport. If the UK spaceport were to be located in Scotland, the country's space economy could be expected to amount to **10%** of the UK total.

The current strength in space manufacturing and space operations should be solidified, and more than 9% of UK total should be achieved for both segments. Space applications should close the gap on the UK total, but is expected to remain of relatively lower importance and achieve a share of less than 9%. Ancillary services in Scotland compete with a strong cluster of especially insurance, finance and legal services in the City of London, and will remain at less than 9% of UK total.

⁴ National statistics do not contain a dedicated space economy, so the companies that operate in space are drawn from a wide range of official sectors. With the exceptions of Programming and Broadcasting activities and Electrical equipment, space activity is a very small proportion of overall value added, with the majority of economic activity not directly related to space.



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