

→ FINAL REPORT ON THE SPACE ECONOMY 2016

EXECUTIVE SUMMARY

Global institutional budget dedicated to space steadily increasing

In 2015, **global government space budgets** were estimated at **€69 billion**¹.

The **U.S.** had a combined civil and defence funding of **€40.2 billion**² for its space programme in 2015, with €21.3 billion (52.9%) going to the Department of Defence (DoD) budget toward national security space activities. NASA received the second largest space budget of **€16.2 billion** in 2015³.

In **Europe**, the overall public budget for space activities remained stable at **€7.2 billion** in 2015. ESA operated with a 2015 budget of **€4.4 billion**, an 8% increase from the 2014 budget. Table 1 below presents the space budgets evolution of major space faring nations using values in domestic currencies, thus avoiding the misleading impact from high currency fluctuations.

Space Budget (million, national currency)	2014	2015	2014-2015 Change
USA (US Dollar)	43,173	44,567	+3.2%
NASA (US Dollar)	17,646	18,010	+2.1%
ESA (Euro)	4,102	4,433	+8.1%
China (Yuan)	26,564	26,100	-1.7%
Russia (Rouble)	165,814	165,814	0.0%
Japan (Yen)	382,700	324,500	-15.2%
India (Rupee)	51,690	57,988	+12.2%

Table 1: Public Space Budgets 2014-2015 change
Source: The Space Report 2016 Space Foundation

Space boosting growth and employment

In 2015, the **global space economy** maintained its long-term growth trend, expanding from 14% compared to 2014 and totalling **€291.4 billion**^{4,5}.

In the upstream manufacturing segment, the **global market value for orbital launches** in 2015 reached **€7.2 billion**⁶, of which 33% on the commercial market. Launching six vehicles with commercial payloads in 2015, Europe earned 27% of the global commercial launch market. The **spacecraft market** generated **€32 billion**⁷ in 2015, of which 17% on the commercial market.

The overall consolidated turnover of the **European manufacturing companies** continued to rise at **€7.5 billion** in 2015, up 4.5% from 2014⁸. The core market of the European space

1 \$76.5 billion The Space Report 2016 Space Foundation - Exchange reference rate from European Central Bank 2015 average: USD 1 = EUR 0.9022

2 \$44.57 billion Ibid.

3 \$18.01 billion Ibid.

4 \$323 billion Ibid. The decrease of the value in U.S. dollar from 2014 to 2015 is due to the growing strength of the U.S. dollar.

5 The Satellite Industry Association provides an estimation of the Global space industry of \$335.3 billion. State of the Satellite Industry Report May 2016 prepared by the Tauri Group for the Satellite Industry Association (SIA)

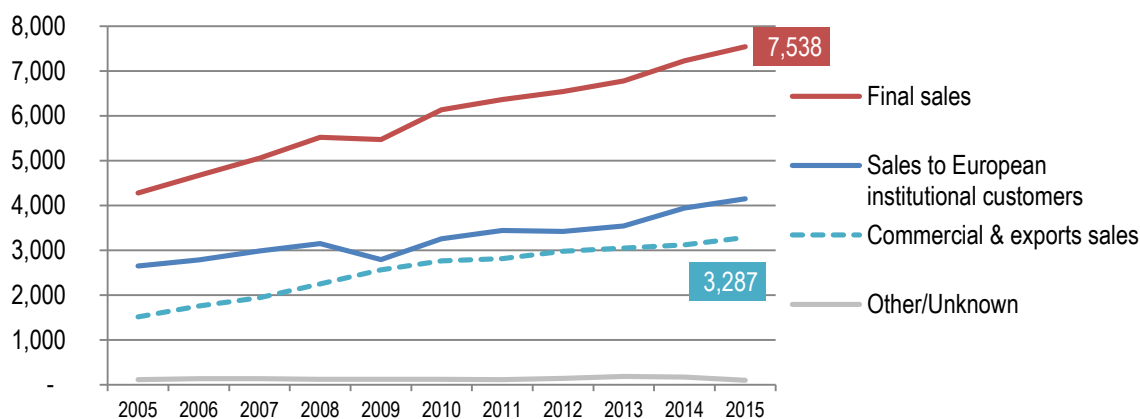
6 \$8.01 billion Prepared by Eurospace for the Space Foundation

7 \$35.51 billion Prepared by Eurospace for the Space Foundation

8 The European space industry in 2015 Facts and figures 20th edition, June 2016 ASD-Eurospace

manufacturers remains their large domestic market with European customers (public and private) representing about 75% of total sales.

On the **commercial and exports markets**, the European manufacturing sales have grown 4% from 2014, reaching a historic peak of **€3.3 billion**⁹, of which 47% were generated by telecommunications systems and 29% by launchers systems. Exports in telecommunications systems represented alone 63% of total exports.



**Figure 1: European space manufacturing sales by main customer segment
2005-2015 (current M€)**
Source: ASD-Eurospace 2016

In the downstream segment, the 2015 **ground stations and equipment** market grew 12% to **€99.7 billion**¹⁰ (GPS equipment revenues represented 75% of the market¹¹). Satellite television, radio, broadband, and mobile equipment is the second-largest category within the defined sub-segment. The **satellite broadcast services** generated **€92.3 billion**¹² in 2015, with DTH television making up the most of revenue (96%). **Satellite communications** segment revenues for 2015 rose to **€19.4 billion**¹³, a level 26% higher than in 2014. The global **satellite-based EO market** continued to expand to **€2.2 billion**¹⁴ in 2015 towards an expected **€4.1 billion**¹⁵ in 2024¹⁶.

Due to engineering complexity of space programmes, the space industry is home to highly skilled professionals. The **U.S.** space industry core workforce has declined 16% over the past 10 years, employing **220,882 employees** in 2015¹⁷. In **Europe**, the space manufacturing segment alone employed **40,196 employees** in 2015¹⁸. **Japan** saw a 3.2% increase in its space workforce, for a total of **8,232 employees** in 2014¹⁹.

⁹ The European space industry in 2015 Facts and figures 20th edition, June 2016 ASD-Eurospace

¹⁰ \$110.5 billion The Space Report The Space Foundation 2016 The Space Foundation defines the “ground stations and equipment” market as encompassing space operations centres, communications networks, remotely operated terminals and tracking stations, satellite phones, satellite television receivers, and navigation chipsets in mobile devices.

¹¹ €74.7 billion European Global Navigation Satellite Systems Agency (GSA) 2016

¹² \$102.3 billion Ibid.

¹³ \$21.5 billion Ibid.

¹⁴ \$2.5 billion Ibid.

¹⁵ \$4.5 billion Ibid.

¹⁶ <http://www.nsr.com/news-resources/nsr-in-the-press/nsr-press-releases/nsr-report-projects-satellite-earth-observation-market-to-reach-45-billion-in-next-decade/> Monday 24, August 2015

¹⁷ Preliminary data for the second quarter of 2015 from the U.S. Bureau of Labor Statistics - The Space Report The Space Foundation 2016

¹⁸ This estimate does not capture the downstream space industry (space services companies, such as launch providers or satellite operators). Companies including Arianespace, SES, Eutelsat, Inmarsat, and together employing thousands of Europeans, are therefore not included in the figure. The European space industry in 2015 Facts and figures 20th edition, June 2016 ASD-Eurospace

¹⁹ Latest available data. The Space Report The Space Foundation 2016

ESA as an engine of the European economic growth

As the main procurement and implementation agency for the European space programmes, ESA has the responsibility to **create value for society** by shaping and setting the conditions for the future technological and market opportunities that drive **sustainable growth** and **job creation**. This objective has been driving an increasing effort in the measurement of key socio-economic indicators (i.e. value-added, employment, government revenues, exports, investment leverage, scientific publications) for the Agency's space programmes, assessing the wide range of impacts of ESA Member States' investments through the Agency on the European Space Economy. In order to facilitate the reader's comprehension and access to the multiplicity of information and data, the impacts have been grouped in homogeneous sets according to the value of programmes associated (i) to space infrastructure, (ii) to space products and services, and (iii) to space science, exploration and education.

Strong economic value of European space infrastructures

The **ISS** development programme has generated an estimated **value added of €14.6 billion**, representing a **multiplier of 1.8** from ESA investments²⁰. Moreover, 36% of ESA spending in the ISS directly contributed to the growth of non-aerospace industry. The average employment multiplier over all ESA Member States has been calculated equal to 1.9, meaning that, following the investment in the ISS, every 100 additional jobs created in the space sector supported 90 additional jobs in the wider economy. The incremental **government revenues** originating from the ISS programme amounted to **€7 billion** in total over 1995-2016. **88%** of the contributions of the Member States on the ISS Programme have therefore been retrieved by governments through different types of taxes and social contributions.

The **Ariane 5** development programme has generated an estimated **value added of €26.8 billion**, representing a **multiplier of 2.2** from ESA investments²¹. Moreover, about one third of ESA spending in Launchers directly contributed to the growth of non-aerospace industry. The average employment multiplier over all ESA Member States when considering the Ariane 5 programme has been calculated equal to 2, meaning that for each new job supported in the space industry one additional job was supported into the wider economy.

The **Copernicus** development programme has generated an estimated **value added of €1.97 billion**, representing a **multiplier of 1.4** from ESA and EC investments²².

In the downstream user segment, Copernicus Sentinel products generate economic value in multiple sectorial value chains²³. For example, in Finland and Sweden, an annual economic value between **€24 million and €116 million** is generated by using satellite radar images for winter navigation in the Baltic Sea. In Sweden, the annual cost reduction ranges from **€16.1 million to €21.6 million** for government regulation using Copernicus satellite radar images in forest management. In the Netherlands, an annual economic value between **€15.2 million and €18.3 million** could be realised from the use of satellite data for gas pipeline monitoring.

20 Socio-Economic Impact Assessment of ESA participation to the ISS programme, PricewaterhouseCoopers, Strategy&, Cambridge Econometrics, September 2016

21 Socio-Economic Impact Assessment of Access to Space in Europe: an Ex-Post Analysis of the Ariane 5 and Vega Programmes, PricewaterhouseCoopers, Strategy&, Cambridge Econometrics, September 2014

22 Study to examine the GDP impact of space activities in the EU. Prepared for the EC by PricewaterhouseCoopers - Strategy&, Cambridge Econometrics, September 2015

23 Case Studies prepared by the European Association of Remote Sensing Companies (EARSC) and The Green Land BV (NL) under a commitment from ESA 2015-2016. Available at <http://earsc.org/news/copernicus-sentinels-products-economic-value-study>

The **Meteorological Operational satellite programme** (MetOp), a European undertaking jointly established by ESA and EUMETSAT, is providing weather data services that are used to monitor climate and improve weather forecasts. It is expected to be one of the most important sources of satellite observations for all forecasts in 2020–40, with benefits ranging from a minimum of **€16 billion to a more likely value of €63 billion**²⁴.

The overall Cost Benefit Analysis for the **Space Weather** (SWE) element of the ESA **Space Situational Awareness programme** (SSA)²⁵ shows a positive result on the initial investment with a **Cost Benefit ratio of 6.5**²⁶. The total benefits (value added of the ESA SWE services) are estimated to reach **€3.1 billion**, distributed through different space (e.g. satellite operators, launch operators) and non-space (e.g. electrical power distribution, aviation, natural resource exploitation) industrial domains. The model estimates the impact of the most significant space weather events in one year to generate a **cost of €15 billion**.

The Cost Benefit Analysis of the **Near Earth Object** (NEO) element of the SSA programme shows that the estimated costs of a NEO impact are **€2.23 billion** for a 50m NEO, **€42.8 billion** for a 140m NEO, and **€3.25 trillion** for a 1km NEO (including fatalities, injuries, land damage and economic losses). The overall analysis broadly shows positive results with a **Cost Benefit ratio of 1.3 [total benefits of €201 million]** for a scenario where Europe increases the NEO detection and cataloguing capabilities, and **1.4 [total benefits of €305 million]** for the deflection mission scenario over the next 9 years²⁷.

Finally, the analysis of the **Space Surveillance and Tracking** (SST) element of the SSA programme concluded that, with an investment of about €1.7 billion, Europe would significantly reduce the strategic dependencies on the US SST services and change the role of Europe from a US SST data user to a key US SST partner, therefore becoming a row model to the international space community²⁸, and providing a unique contribution to the global space debris challenge.

Space products and services supporting Europe's competitiveness

The **EO services market**²⁹ is seizing opportunities from the convergence of the big data and digital revolutions. In Europe and Canada, the number of EO service companies is posting a growth of 8.7% p.a., the sector's **turnover is increasing at a rate of 7.6% p.a. and the employment is posting a growth of 11% p.a.** Public customers dominate with a total market share of 65%.

The ESA EO Scientific Strategy³⁰ fosters the use of EO services as a strategic response to major societal challenges, in particular the new set of United Nations Sustainable Development Goals. ESA has set 27 demonstration contracts for European EO value-adding companies to deliver the required EO-based information services to major International Financing Institutions³¹. Follow-on have activities have been directly generated, occurring on a **financial scale 5-6 times greater** than the initial ESA investment. EO being fully adopted

24 The Case for EPS/METOP Second Generation: Cost Benefit analysis, Eumetsat December 2013

25 An ex-ante cost benefit analysis of the SSA programme, PricewaterhouseCoopers, Strategy&, Met Office, September 2016

26 In view of a capital investment of €307 million and operational expenses of €166 million.

27 Estimates for the total CBA are provided across a 9-year timeline, referring to the length of ESA's capital and operational expenditure. The scope of the analysis therefore doesn't capture the benefits that will be generated after the programme's initial investments.

28 i.e. by cataloguing a percentage of debris equal to that of satellites operated by Europe

29 A survey into the State and Health of the European EO Services Industry 2015, prepared by EARSC under assignment from ESA September 2015

30 Earth Observation Science Strategy for ESA 4 November 2014 ESA/PB-EO(2014)38

31 12 for the World Bank (completed in 2012), 10 for the European Investment Bank (completed in 2013) and 5 for the UN International Fund for Agricultural Development (completed in 2013). Contracts were financed and completed at the total cost of €2.7 million.

and integrated on a systematic basis into the complete international development sector could represent a volume of economic activity with an order of magnitude of €200-300 million per year.

The **ARTES³² Integrated and SatCom Space Applications / Services** programme is successfully supporting the delivery of operational services. Ensuring a strong user engagement, projects are developed on the basis of sustainable business models. Building on an initial ESA funding of €67 million, 61 projects have generated revenues of €210 million to date, a revenue vs. ESA funding ratio of 3.2 to 1. The ratio is estimated to reach 12.8 to 1 by 2020³³. The ARTES IAP “quality brand” has already allowed 27 projects to attract additional 3rd party investment of €55.4 million and a high level of exports representing 68% of revenues.

The **ARTES Competitiveness and Growth Products** programme is successfully supporting the development of new products or improvement of existing ones, thus improving the overall competitiveness of European companies in the commercial market. Building on an initial ESA funding of €30 million, 26 projects have generated revenues of €63 million to date, a revenue vs. ESA funding ratio of 2.2 to 1. The ratio is estimated to reach 7 to 1 by 2020³⁴.

The **ARTES Public-Private Partnerships** programme is generating returns on Member States’ investment from 1.3 to 2.6.

After 10 years of operations of the **ESA BIC programme**, 144 companies have been incubated by the ESA BICs and have graduated successfully, becoming “Alumni”³⁵. In 2014, 39 ESA BIC’s Alumni have been able to raise €20 million of investments to grow their business, representing a dramatic increase of more than 500% over the last reporting period (which reported 20 companies raising €3.5 million in 2012). With an average of 3 patents per ESA BIC, the performance represents a level 30% higher than the one shown by the EU|BIC network. The survival rate is 87%.

Space science, exploration and education fostering European excellence

An independent scientific review³⁶ confirmed the **Earth Observation Envelope Programme (EOEP)** as a world-leading programme activity for the development and execution of challenging Earth observing research missions that address key scientific challenges, while demonstrating breakthrough technology in observing techniques. EOEP has developed a unique international community, with 300 industrial and academic teams involved in programme implementation, 2,000 scientific peer-reviewed publications in international journals by ESA PIs (Principal Investigators), 180 public sector and international research organisations engaged with ESA for new EO products, and more than 12,000 registered users worldwide. Key examples of technological/hardware achievements include the Biomass low frequency SSPA, the Ka-band Downlink system (for MetOp-SG), the ultra-stable laser for interferometric measurements or the next generation UV laser for MERLIN.

32 ESA/JCB(2016)20, rev. 2 - Socio-Economic Impact and Return on Investment of ARTES programmes

33 Estimated revenues discounted using a 5% discount rate.

34 Estimated revenues discounted using a 5% discount rate.

35 ESA BIC Network Alumni Report 2014 Preliminary results as of February 2016

36 Science Review Report 2015 Assessment of the Scientific Benefits of the European Space Agency’s Earth Observation Envelope Programme, conducted in the framework of the EOEP-4 review.

The **ESA Climate Change Initiative (CCI)** has contributed to a rapidly expanding body of scientific knowledge and demonstrated new insights in international climate research. CCI made important contributions to the IPCC's 5th Assessment Report³⁷: **27 CCI scientists** were involved as leaders, contributing-authors or editors in **7 of the 14 chapters** of the report, and CCI results were **cited 59 times**.

The socio-economic benefits of the **Science Programme** missions are realised through the wealth of scientific results produced by the scientific community making use of the missions' data. In 2015, a total of **1,870 refereed papers** were published based on data from ESA-led missions, a level **11% higher than in 2014**³⁸. The total number of refereed astrophysics papers published in 2015 as obtained from the ADS³⁹ database is 23,386, implying that **13% of all astrophysics refereed papers** published in 2015 were based on data from ESA- or partner-led Science Programme missions.

In terms of industrial output, the European space scientific programmes manufacturing revenues amounted to **€1.2 billion** in 2015, confirming the positive trend of about **16% increase** from 2012-2013 values.

Space exploration also creates intangible benefits namely through inspiring the younger generation and the public at large. **More than 70%** of Europeans had heard or read about Rosetta. The outreach impact of the Rosetta mission ended with **10 million people** watching the landing live stream, **13,584 articles** published online, **908 million views** and **#1 global trending topic** on Twitter.

In 2015, in close collaboration with national and European institutional partners, about **450 teacher training sessions** coordinated by the **Education Office** have been attended by almost **5,800 primary/secondary teachers**, potentially reaching out about **174,000 pupils**; at least **16,000 university students** benefitted from e-learning opportunities, and at least 950 were directly involved in unique educational hands-on space programmes, benefitting from direct transfer of competence by ESA specialists⁴⁰. The students also organised events, conferences and other outreach and media initiatives, thus contributing to inspire a vast audience of other students and the general public.

37 Data from ESA missions is cited throughout the IPCC's Working Group I, 5th Assessment Report (AR5, 2013), specifically: ERS-1: Altimeter, ATSR, SAR, Wind Scatterometer; ERS-2: Altimeter, ATSR-2, SAR, GOME, Wind Scatterometer; Envisat: RA-2 (altimeter), AATSR, ASAR, MERIS, MIPAS, SCIAMACHY, GOMOS; as well as the Earth Explorers: SMOS and Cryosat-2.

38 ESA/SPC(2016)13 Programme's Performance in 2015 and Science Key Programme Indicators (KPI's) 9 June 2016

39 The SAO/NASA Astrophysics Data System (ADS) is a database containing a broad selection of journal articles.

40 ESA/C(2016)61 Status Report on Education Activities 1 June 2016

Socio-Economic Impact Assessment of ESA participation to the ISS Programme in numbers

GDP Impact

Total ESA investment in the ISS in B EUR over all periods

8



Distribution of ESA spending in different sectors

1 Euro spent in the programme produces a total of **1,8** Euro of value added in the economy

Government revenues in B EUR

7

Employment multiplier

1,9

Wider impacts

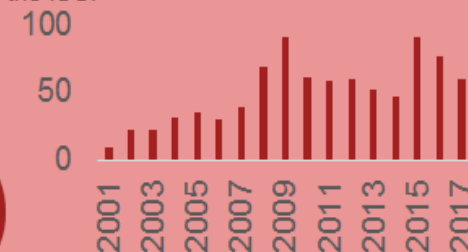
International Cooperation

Four international projects are underway because of the proved European excellence demonstrated on the ISS Programme.

Partnership	Agencies
Orion MPCV	NASA, ESA
ExoMars	ESA, Roscosmos, NASA
Luna program	Roscosmos, ESA
OPSEK	Roscosmos, ESA

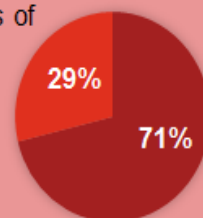
Fundamental Sciences

867 experiments and 344 investigations have been made on the ISS.



Inspiration

The ISS is a very popular topic for the general public, **71%** of the total views of the ESA YouTube page are related to videos filmed on the ISS.



Space Technology

The majority of stakeholders benefited from additional projects that they received after working on the ISS. Every euro awarded as contract generated in average 2,2 euros in additional benefit for the companies.

An economic stimulus that extends far beyond the space sector alone

Socio-Economic Impact Assessment of Access to Space in Europe: an Ex-Post Analysis of the Ariane 5 and Vega Programmes

GDP Impact

Total ESA investment in Ariane 5 and Vega Programmes (1998 – 2012) in B EUR

13,2



Distribution of ESA spending in different sectors

1 Euro spent in the launcher programmes produces a total of **3.2** Euro of value added in the economy (taking into account the additional GVA from exploitation)

Government revenues in B EUR

11.5

Employment multiplier

For each new job supported in space thanks to the launcher programmes 1 additional job was supported in the wider economy

2

Wider impacts

Wider economic impact

Each euro spent in the launcher programmes directly enabled **4.1** euros in the wider European economy **(and indirectly brought upon 4 additional euros when considering overall sales, for a total sales multiplier of 8.1)**

Societal Benefits

The programmes increased university outreach impact, student enrolment in STEM subjects, curricula development and scientific production.

Workforce skills improvements and human capital development were felt beyond the aerospace sector, both in technical and management fields

Fundamental Sciences

More than 80 patents were registered for technology that was developed for the launcher programmes.

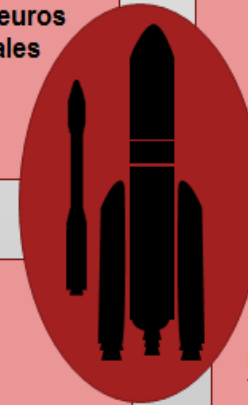
Likewise, **more than 150 publications** were made on the basis of materials linked to the launcher programmes.

Technology and industrial development

New technology developments were exploited in non-space markets, within and outside the EU.

The programmes brought to Europe:

- New infrastructures and production facilities
- Workforce skills improvements and human capital development, both in tech and management
- A strong positive brand impact for the companies.



An economic stimulus that extends far beyond the space sector alone