

ESO's Role in Advancing the UN Sustainable Development Goals

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Building on decades of work, in 2015 the United Nations Member States adopted the 2030 Agenda for Sustainable Development¹, based around a set of measures formulated to be a guiding plan of action to improve human lives and protect the environment, namely, the Sustainable Development Goals (SDGs²). The main aim of the SDGs is to eradicate poverty in all its forms, the achievement of which requires that all countries and stakeholders work together to implement strategies that improve health and education, reduce inequality, address climate change, and spur economic growth. The United Nations General Assembly has proclaimed 2022 as the International Year of Basic Sciences for

Sustainable Development, the goal being to highlight the role of basic sciences in supporting sustainable development.

The European Southern Observatory (ESO), with 16 Member States across Europe along with the host and partner state of Chile and with Australia as a strategic partner, supports the achievement of the UN SDGs in their three different dimensions: economy, society, and environment. Through its mission to design, build, and operate world-leading observational facilities that help advance our knowledge about the Universe, as well as to foster international cooperation for astronomy, ESO has a role to play in achieving the goals and targets set by the UN by being a driver of scientific research and supporting education activities at all levels across the world.

ESO contributes to 13 out of the 17 SDGs (highlighted on the graphics below). The goals that ESO contributes to are related to improving quality in education, striving for diversity, equity, and inclusion within

educational, science and engineering settings, goals related to technology, innovation, peaceful scientific cooperation, as well as environment and health. In what follows, examples of ESO initiatives and actions that contribute to each development goal are briefly described.

Good Health and Well-being (SDG 3)

ESO contributes to the third SDG, Good Health and Well-being, through its advocacy for preserving the dark night skies and by enabling the development of technology that finds uses outside of astronomy, including in medical applications.

Preserving the darkness of the skies goes beyond astronomical research. There is a wealth of scientific literature studying the impacts on light-polluted skies on human health. For instance, the 2017 Nobel Prize of Medicine or Physiology, was awarded to individuals whose discoveries suggest that the human body clock requires natural daylight rhythms and dark skies to

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function properly. Artificial light has been linked to low levels of human melatonin, which might lead to health risks. Moreover, scientific studies suggest that artificial light increases the risk of depression, sleep disorders, obesity, and cancer. Further, the dark night sky is a source of awe, education, outreach and community, with stargazing having the potential to promote health and wellness in society. Stargazing has been shown to offer benefits to human wellbeing by nourishing positive emotions and connectedness with nature. By actively advocating for the protection of the dark sky, ESO, in collaboration with other observatories and the Chilean government, is making its own contribution to healthy lives across the planet³.

The development of ESO's cutting edge instrumentation involves a wide range of technology development. Through the EU-funded ATTRACT initiative, the German institute innoFSPACE is transferring astronomical technology from the MUSE integral field spectrograph on ESO's Very Large Telescope into cancer diagnostics tools.

Quality Education (SDG 4)

ESO plays a pivotal role in training early-career astronomers, astrophysicists, engineers, and communicators of science from across the world. Training is done through a broad range of programmes and initiatives, such as studentships, fellowships, internships, and summer research programmes. In the last decade, ESO has trained over 260 students in science and engineering from more than 40 countries, over 90 interns in science communication, graphic design, astronomy, engineering, and science policy and diplomacy, and hosted over 150 postdoctoral fellows in astronomy and engineering from more than 30 countries. In Chile specifically, ESO funds post-doctoral programmes in astronomy at Chilean academic institutions and provides studentships at the ESO offices in Santiago for students enrolled in Chilean universities. After participating in these training programmes, these young professionals are equipped with a relevant set of transferable skills, such as in data science, programming, and/or machine learning.

Through the ESO Supernova Planetarium & Visitor Centre, located in Garching, Germany, ESO promotes and increases scientific literacy in society and inspires children and young people to engage in science, technology, engineering, and mathematics (STEM). Since opening in spring 2018, the centre welcomes around 70 000 people each year. The education programme of the ESO Supernova is offered completely free of charge and is available to all compulsory stages of education, from kindergarten through to the end of secondary education. Over 9000 of the annual visitors are school pupils and their teachers, typically coming from more than seven different countries each year, who engage with at least part of the education programme. A further 350 teachers and educators are engaged annually in professional development activities.

ESO also supports other organisations in their astronomy education endeavours by providing open-source materials, enabling facilities around the world to share the fascination of astronomy with as varied an audience as possible.

Furthermore, ESO also promotes quality education by making the data from observations conducted with its telescopes public. The petabyte-sized ESO Science Archive contains open data from all ESO telescopes, which can be used for research, education or outreach purposes. ESO also has an extensive database of images and videos for outreach purposes. By making these materials available for free, ESO ensures that audiences everywhere can experience the wonders of the cosmos.

Closing the Gender and Inequality Gap (SDGs 5 and 10)

ESO is committed to equity, diversity and inclusion⁴ and believes that astronomical education and research can be a tool to empower and inspire women around the world and bring people of different backgrounds together in collaborations.

The ESO Diversity & Inclusion Committee advises ESO's management on goals, policies and good practices pertaining to all aspects of diversity. ESO is a member of the GENERA Network (Gender Equality

Network in Physics in the European Research Area), fostering global collaboration over gender equality policy in physics between research organisations, associations, and consortia.

A memorandum of understanding between ESO and UN Women was signed in 2020 with the goal of assessing the gender gap in STEM careers, focusing on creating training opportunities for women, particularly in the Antofagasta region in Chile. Antofagasta is the closest hub to ESO's Paranal Observatory, and the city hosts ESO support offices. Under the framework of this agreement, ESO has participated in the Second Chance Programme (Tu Oportunidad) by training a group of women at Paranal Observatory in key astronomical technology skills, such as coating large telescope mirrors, allowing them to expand their job opportunities. In addition, members of ESO staff take part in LIQCAU: + Mujeres en Ingeniería, a mentoring project led by the Universities of Antofagasta.

Economy, Technology and Innovation (SDGs 8 and 9)

ESO invests in engineering, science, and innovation to design and build advanced telescopes and state-of-the-art instrumentation by developing new technologies such as astronomy technology in optics, engineering and intercontinental data transfer, medicine and imaging, sensor and detector technology. In this way ESO generates new markets, job opportunities, and industrial collaborations, and is contributing economically to society. As presented in the dedicated report ESO's Benefits to Society⁵, ESO's economic impact can take several different forms: from direct industrial return to suppliers, economic and innovation effects, to improved expertise and the creation of new jobs and multiplier effects in individual countries. For instance, over 80% of the € 1.3 billion development construction budget for ESO's upcoming Extremely Large Telescope (ESO's ELT) is being invested in contracts with industry. These contracts are primarily distributed across ESO's Member States, providing significant industrial return to these countries, creating new jobs and promoting the emergence of new technologies and expertise.

Adaptive optics systems, necessary to correct the blurring that Earth's atmosphere causes, rely on fast and low-noise sensors, as well as on powerful lasers. ESO initiated collaborations between industry and academic groups which have led to the development of two different detector technologies working in different wavelength regions. ESO has played a central role in these developments, both of which have resulted in technology transfer to industry, subsequently resulting in commercial products that are used in a variety of other research fields. ESO, together with its industry partners, has worked to develop compact powerful lasers, which are currently in operation on ESO's Very Large Telescope (VLT) and will be used on the ELT in the future. This has been the first transfer of patented technology from ESO to industry. In addition to their application in astronomy, the high-powered lasers have uses in the fields of space situational awareness and optical satellite communications, which open up opportunities for further markets for the technology.

Climate, Environment, Sustainability, Clean Energy and Life on Earth (SDGs 7, 11, 12, 13, and 15)

Environmental awareness and sustainability are core values for ESO and the organisation is developing and implementing a comprehensive environmental strategy in order to reduce its carbon footprint and the environmental impacts of its operations⁶. ESO's work, while providing astronomers worldwide with the best tools to enable key scientific discoveries and benefiting society in many ways, places significant demands on the environment and resources. Thus, ESO strives to reduce its carbon footprint and environmental impact.

One of the key ways in which ESO is mitigating its impact on the environment is by running its observatory sites on renewable energy. The observing facilities at ESO's La Silla and Paranal sites in Chile are powered by clean, renewable energy coming from photovoltaic plants built near the observatories. The goal is to have 100% of operations at the sites supplied by these power plants. All the renewable energy not used for scientific

operations is injected into the Chilean energy grid. In future, the Paranal photovoltaic power plant will also supply energy to ESO's ELT.

ESO is committed to reducing the environmental damage of long-distance travel by making extensive use of video-conferencing facilities, saving up to 800 tonnes of CO₂ equivalent per year. On site, ESO is gradually replacing its fleet of vehicles with electric cars and aims to use no fossil fuels across all ESO's sites.

The facilities that make up ESO's Garching headquarters extension office buildings and a technical building, inaugurated in 2013, have significantly lower energy consumption than typical for buildings of similar size. This is due to the well-insulated façade and the fact that the office building is heated and cooled through concrete core activation: ground-water is used together with a heat pump and supplied with district heating using geothermally heated water. Green measures have also been incorporated into the design of the ESO Supernova Planetarium & Visitor Centre. The facility received the DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen or German Sustainable Building Council) Gold certification for sustainability with respect to its green economical, socio-cultural, technical, and ecological aspects.

Another way in which ESO contributes to an environmentally sustainable planet is through its initiatives to preserve the dark night skies. For example, there is substantial evidence that lit night skies have a negative impact on wildlife or contribute to increasing a region's climate footprint.

ESO as a model for peaceful scientific cooperation (SDGs 16 and 17)

ESO is a model for peaceful scientific cooperation by promoting international political and cultural understanding between society, science, and technology for the benefit of humankind. The organisation is well suited to this role as collaboration has been part of the organisational culture of ESO since its foundation in the 1960s, and international partnerships penetrate every aspect of its operations. It encourages countries to

work together to create a scientific, technological, and policy capacity for development that is beyond the reach of each of its Member States alone.

Given ESO's position as a centre of gravity for astronomy in Europe, ESO is firmly embedded in, and has an impact on, European science policy. ESO is a founding member of the European Intergovernmental Research Organisations forum (EIROForum) that brings together eight of Europe's largest research organisations with extensive expertise in the areas of basic research and the management of large, international infrastructures, facilities, and research programmes. The mission of EIROForum is to combine the resources, facilities and expertise of its member organisations to support European science in reaching its full potential, both in their technical and scientific areas, as well as in diversity, equity, and inclusion-related issues and challenges.

Furthermore, ESO has a permanent seat on the UN's Committee on the Peaceful Uses of Outer Space and has made key policy contributions to the assessment of the impact of satellite megaconstellations, safeguarding the dark sky, and protecting Earth from asteroids. As for the last of those, ESO is a member of the UN-mandated International Asteroid Warning Network, which is a global collaboration that monitors the skies for potentially threatening asteroids. ESO is also one of the vectors of scientific cooperation between Europe and Latin America. The construction of new observatories in Chile generates an ideal scenario for exchange between Chilean, Latin American, and international scientific communities. The creation of ESO's regional relations office at the end of 2019 is a clear sign of ESO's commitment to strengthening its presence and dialogue with Chilean communities.

Concluding remarks

The UN SDGs provide a useful high-level guide to understanding and communicating how ESO contributes to an agenda broader than its defined mission. ESO can now communicate these successes to its stakeholders and ensure that the basic principles of the UN SDGs and the

values they espouse are intrinsic to ESO's own defined values. This is more than communication and PR, however. While the organisation cannot deviate from its mandated mission, the framework of the UN SDGs helps to ensure that each step taken to deliver world-leading astronomy facilities is seen through a sustainability governance lens. ESO's operations are

gradually being infused with more sustainable practices.

Links

- ¹ UN 2030 Agenda for Sustainable Development: <https://sdgs.un.org/2030agenda>
- ² UN Sustainable Development Goals: <https://sdgs.un.org/goals>

- ³ Dark and quiet skies preservation at ESO: <https://www.eso.org/public/about-eso/dark-skies-preservation/>
- ⁴ Diversity, Equity, and Inclusion at ESO: <https://www.eso.org/public/about-eso/sustainability/dei-at-eso/>
- ⁵ ESO's Benefits to Society report: https://www.eso.org/public/products/brochures/brochure_0076/
- ⁶ Environmental sustainability at ESO: <https://www.eso.org/public/about-eso/green/>



Three-colour composite mosaic image of the Eagle Nebula (Messier 16, or NGC 6611), based on images obtained with the Wide-Field Imager camera on the MPG/ESO 2.2-metre telescope at the La Silla Observatory. At the centre, the so-called "Pillars of Creation" can be seen. This wide-field image shows not only the central pillars, but also several others in

the same star-forming region, as well as a huge number of stars in front of, in, or behind the Eagle Nebula. The cluster of bright stars to the upper right is NGC 6611, home to the massive and hot stars that illuminate the pillars. The "Spire" — another large pillar — is in the middle left of the image.