Astronet section on
Societal Aspects of Astronomy

Introduction (0.5 p)

The universe is larger and more diverse, dynamic, and enigmatic than our ancestors could have imagined when they first gazed at the stars. The captivating and mysterious nature of the universe makes astronomy fascinating to the public and a fertile ground for the imagination of young and old minds alike. Astronomy is also inseparable from the rest of society.

The astronomy structures dedicated to facilitating or conducting research keep increasing with Europe. Astronomy research requires unique technological developments, data management systems and highly-skilled research staff. This research can lead to opportunities for innovation and market development, can attract investments and contribute broadly to socio-economic development.

This section explores relevant societal aspects of astronomy within the European context.

Social and cultural relevance of astronomy: Astronomy has always had a significant impact on our world, with the power to inspire and unite people from a variety of different cultures and across all age groups. Early civilisations studied celestial objects to measure time, mark the seasons, and navigate across vast oceans. Now, as our understanding of the world progresses, we find ourselves and our view of the world even more entwined with the Universe. The discovery that the basic elements that we find in stars, the gas and dust around them, are the same elements that make up our bodies has further deepened the connection between us and the cosmos. Astronomy also helps us to broaden our perspectives and to think on grander scales. Our connection to the cosmos and the awe it inspires, is perhaps the reason that the beautiful images astronomy provides us with are so popular in today's culture.

The technological impact of astronomy: Astronomy and related fields are at the forefront of science and technology; answering fundamental questions, pushing engineers to new levels and driving innovation. Astronomy has been an important driver for the development of advanced technology, such as the most sensitive detectors of light and radio waves and the fastest computers. The need to study the faintest objects requires sophisticated electronics and extreme-precision adaptive optics as well as state-of-the-art engineering. Modern telescopes are among the most advanced machines ever built and are outstanding educational vehicles for introducing the latest complex technology. Among those, the LIGO/Virgo gravitational wave observatory is an example of the most precise laser interferometer ever built by humankind. A 40-years long endeavour that pushed the

laser and precise measurement technology to a never imagined before level. Astronomers are also trained data scientists with elaborate skills in data analysis and coding: 21st-century skills that are transferable to many societally relevant applications. Although blue-skies research like astronomy rarely contributes directly to tangible outcomes on a short timescale, astronomy has a wealth of examples of day-to-day technologies that were initially developed by astronomy research (Rosenberg et al. 2014). The fruits of scientific and technological development in astronomy have become essential to our day-to-day life, with applications being integrated in many devices that play a vital role in society such as personal computers, communication satellites, mobile phones, digital cameras, GPS, solar panels, Magnetic Resonance Imaging (MRI) scanners and more recently ventilators during the global pandemic. Due to this cutting-edge technology and the international nature of astronomy research, astronomy is synergetic to the UN Roadmap for Digital Cooperation.

The Universe as an Open Lab: The Universe provides a unique laboratory for studying extreme conditions that are inaccessible on Earth. Stars and galaxies are environments that have produced the chemical elements around us and formed organic molecules, the building blocks of life. During the last century astronomical studies have led to new discoveries in physics, chemistry and biology and to the creation of the new sciences of astrophysics, astrochemistry and astrobiology. Because of its interdisciplinary approach, astronomy is also an excellent tool for education in STEM fields. Astronomy is also at the forefront of the Open Science movement: Open access to raw data is the standard in astronomy. This is supported because it promotes productivity and competitiveness. It is also common that scripts, libraries, codes and programming tools are open source, so everyone can use them and contribute to improving these tools. Scientific articles are available as open-access on arXiv, making the science more inclusive to all scientists and the general public. Open science is extremely relevant to a data-intensive science like astronomy and even though many open science practices and tools are already present, every astronomer needs to be trained in these skills for it to become the norm (Norman, D. et al (2019)).

A gateway to the learning and appreciation of science in general: One of the most important societal functions of modern astronomy is as a "gateway science" for education in the broadest sense (Salimpour et al. 2020). Since it is one of the most approachable of sciences, and one that consistently fascinates young people, astronomy is an excellent vehicle for introducing science and technology to children (ROSE, Sjøberg S. (2020)). The accessibility of the sky, the beauty of cosmic objects and the immensity of the Universe are inspirational and provide a perspective that encourages inclusiveness and tolerance. The excitement of astronomy has stimulated large numbers of young people to choose a career in STEM fields, thereby contributing to development of the “knowledge economy” of many countries. Astronomy also interfaces with other cultural fields and it is a source of inspiration for

the visual arts, literature, philosophy and many others (Valls-Gabaud & Boksenberg, 2009).

Commenté [1]: Perhaps add here a few recent examples

A bridge between science and citizenship: Astronomy also has a strong presence in public engagement (e.g.: IAU100) and citizen science (e.g. the Zooniverse) to promote the science methodologies (Marshall et al. 2015) and more broadly key skills such as critical thinking and multiperspectivity, which are fundamental today as learners are living in increasingly diverse societies. By fostering a deep appreciation for our planet-, Astronomy also provides a powerful means to raise awareness around issues of sustainability and responsible engagement to preserve life on earth (e.g. the international initiative to combat and reduce light pollution).

1. *Technology Transfer / Industry Relations*

It is obvious that scientific advances in astronomy are to a large extent driven by technological advances, which, in turn, are often enabled by close collaborations between astronomers and industrial partners. Through *spin-in*, new technology that is developed for commercial applications can inspire radically innovative astronomical instruments (e.g. developments in the telecom industry leading to fiber-based or photonics-based instruments, the application of liquid-crystal technologies that have been developed for displays, high-volume internet and computing capabilities that enable huge radio telescopes, etc.). However, there are likely as many good examples of *spin-off*: technology that was originally specifically developed for astronomy that has applications elsewhere. The example that astronomers always like to emphasize (and claim) concerns the invention of WiFi, and several other success stories have been collected[1].

This does not merely pertain to high-tech hardware solutions, but the current big data / artificial intelligence revolution also certainly prominently features astronomers in starring roles. However, there is no complete overview of the impact of astronomical technology development on our society, both in terms of quantitative return on investment for the economy, as well as in terms of qualitatively improving our lives on Earth. With the ambitions layed out in this roadmap with respect to both hardware and software projects, the collaborations between astronomy and industry are likely to be intensified and enhanced, and it seems more than opportune to study the results of these developments at different levels and time-scales.

The OECD provides a framework for assessing the impact of investments in science and technology, and for the “space industry” it is estimated that every Euro invested into advanced new infrastructure gets multiplied several times in terms of economic benefits[2]. More importantly, the much broader range of socio-economic benefits captures the true impact of investments, which is probably even more appropriate for specifically astronomy. However, such a specific study into the range of impacts of technology development for astronomy does not exist, and this Astronet roadmap presents a unique opportunity to implement this for a range of different projects. This will not only provide ammunition to better justify the “commercial” case for astronomy, but, in conjunction with the other subsections of this chapter, will demonstrate how astronomy contributes to building a better world.

Commenté [2]: Perhaps add a line on how this could be done and what is neededede

To further enhance the potential of (socio-)economic impact, it may be recommended for large projects and long-term collaborations between astronomy and industry to establish and communicate joint R&D agendas. Furthermore, educational (BSc/Msc) and research (PhD/post-doc) programs at universities and

[1] https://www.iau.org/static/archives/announcements/pdf/ann19022a.pdf
[2] https://www.oecd.org/innovation/the-space-economy-in-figures-c5996201-en.htm

research institutes can already intimately connect to (local) industry in the form of internships, dedicated courses, or entire joint (interdisciplinary) programs on astronomy-themed advanced instrumentation and/or data science. Because, in the end, a major spin-off from astronomy is of course in the form of human capital of highly trained academics that go into industry.

Intensive joint educational and research programs are already existing and emerging, and while there is not yet any cause for major concern, we emphasize that academic freedom and independence needs to be guaranteed at all times when collaborating with industry, to prevent any conflicts of interest. Ethical issues pertaining to for instance companies that also operate in the defense industry always need to be openly discussed upfront.

Finally, having said all this, we need to continue making strong cases for investments in fundamental science, just for the sake of fundamental science.

Recommendations:

- Further develop training programmes (MSc, PhD and PostDoc level) in close cooperation with industry (Dual-programmes)
- Actively scout for "spin-in"opportunities, new technology that is developed for commercial applications can inspire radically innovative astronomical instruments
- Support spin-off opportunities: technology that was originally specifically developed for astronomy that has applications elsewhere.
- Further train astronomy PhD students for market-ready, including an ECU entrepreneurship programme for astronomy graduates (e.g.: Based on H2020 SKIES)

2. *Astronomy Education*

There are a number of transformative efforts in how astronomy education projects are designed and executed that have the potential to reshape the experience of astronomy learners and alter the astronomy education ecosystem.

Astronomy's presence in many European educational curricula is irregular. Some countries have astronomy subjects at many different levels, and others countries have only few mentions in the natural sciences curriculum. -The ECU-funded project, Space Awareness (2019) did a preliminary assessment of the European curriculum, and more recently, Salimpour et al. (2018) reviewed the astronomy presence in the curricula of the countries in the Organisation for Economic Co-operation and Development (OECD). They noted that astronomy-related content was prevalent across the 52 curricula of the European and OECD countries. Content topics relating to basic astronomy such as telescopes and optics were the most prevalent, while topics related to cosmology and current research in astronomy were less common; material related to robotic telescopes was absent, probably due to the limited content- knowledge of curriculum developers, policymakers, and even teachers. Astronomers can and should engage with curriculum developers to bring modern cutting-edge astronomy research with emphasis of Big Science and Big Data to the national curricula.

Another important practice is to work with educational textbook publishers, as has been done e.g., with the Space Scoop text in English-language books (Reynolds 2014), South African textbooks, and Dutch Physics textbooks. Astronomers can work closely with textbook publishers to foster the use of more astronomy resources in educational material across different school subjects, especially by reviewing and developing the content of specific textbooks. In these ways, a much wider reach of astronomy content in textbooks and related materials can be realized.

Global Citizenship Education: Learning Through Perspective

The cosmic perspective that astronomy provides makes it an important tool for Global Citizenship Education (GSED), UNESCO's educational approach to tackle global issues that threaten peace and sustainability (UNESCO 2014). GSED Global Citizenship Education empowers learners of all ages to assume active local and global roles to build more peaceful, tolerant, inclusive, and secure societies. For example, teaching the "Pale Blue Dot" concept from Carl Sagan can function on several levels:

- Cognitive: "I wanted to be a scientist from my earliest school days. The crystallizing moment came when I first caught on that stars are mighty suns, and how staggeringly far away they must be to appear to us as mere points of light" (Sagan 1994a).

- Socio-emotional: “Fanatical ethnic or national chauvinisms are a little difficult to maintain when we see our planet as a fragile blue crescent fading to become an inconspicuous point of light against the bastion and citadel of the stars” (Sagan 1980).
- Behavioural: “Look again at that dot. That’s here. That’s home. That’s us.” It makes clear“To me, it underscores our responsibility to deal more kindly with one another, and to preserve and appreciate cherish the pale blue dot” (Sagan 1994b,).

Several European educational programs use this approach, including Universe Awareness (UNAWE) and the Big History Project. UNAWE is a global science education program using the beauty and grandeur of the universe to encourage young children (4 to –10 years old), particularly those from an underprivileged background, to have an interest in science and technology and foster their sense of global citizenship. There is evidence that using astronomy as an intervention contributes to the motivation, science knowledge, science skills development, and intercultural awareness in these learners (Kimble 2013).

Big History is an educational and storytelling approach to recount the “history of the universe over time through a diverse range of disciplines including physics, chemistry, biology, anthropology, and archaeology/. Thus, traditional human history is reconciled with environmental geography and natural history” (Simon et al. 2015). In the past five years, this approach has received more attention and funding (Sorking 2014) as well as a complete teaching website. The Big History Project was developed using evidence showing that students using this approach have made gains in reading, writing, and content knowledge (Big History Project 20158).

Beyond Science Literacy: Science Capital

Bucchi & Trench (2014) have asked for a move from the “teach them the simple facts” an approach that teaches the simple facts to a “capital-based” approach to science literacy. Science capital, a concept introduced by the ASPIRES UK policy report (Archer 2013), represents the sum of all science-related knowledge, attitudes, experiences, and resources that individuals build up throughout their life. This includes what science they learn and know from all different types of learning environments (formal or informal), what they think about science, the people they know who understand science, and the day-to-day engagement they have with science (Archer et al. 2015). Capital can be created through lifelong diverse learning opportunities for children, adolescents, and adults within a robust, community-wide system for science education (Falk et al. 2015). This perspective of an educational ecosystem encourages the building of partnerships that can support the STEM learning of young people across multiple settings (Schatz & Dierking 1998). This translates to developing opportunities for learners to participate in the astronomy

enterprise, including collecting and analyzing astronomy research data (Roth & Barton 2004).

An understanding of “science capital” offers the practitioner or project designer a powerful conceptual lens to identify interventions which canwhich that can address disparities in science engagement and participation (DeWitt et al. 2016). For example, cultivating a “growth mindset” to improve skills and suppress self-criticism (Dweck 2016) in adolescents can aid their science achievement and appreciation. This approach has been effective in art-–science programs that emphasize a creative cycle of design experimentation, prototyping, evaluation, and redesign (Conner et al. 2017, Tsurusaki et al. 2017). Recent research using online interventions that teach students that intellectual abilities can be developed have proven effective in improving grades in lower-achieving students, even though the intervention lasted less than one hour (Yeager et al. 2019)!

A science capital approach can also encourage schools to become less isolated in their communities. Because of the diverse subject linkages described by Miley (2009), astronomy can help schools shift towards “Open Schooling” (Hazelkorn et al. 2015), decreasing the isolation of schools and encouraging creativity, entrepreneurship, and innovation as the schools collaborate with businesses and the larger society. The astronomy enterprise naturally engages with these different stakeholders and can create new partnerships among teachers, students, researchers, innovators, industry professionals, and other stakeholders in science-related fields.

Commenté [3]: is this based on a study?

3. *Public Engagement -with Astronomy*

"*Scientists, keep an open line of communication with the public*" (Monteiro, 2020), this call for action from the editor of Nature Medicine in October 2020 comes at a time where our society still struggles with a global pandemic, fights for social justice and surfers from climate change. -Scientists need to have open communication with the public and engage fellow citizens with research activities. Public engagement with science is not any longer a nice-to-have, it is a must-to-have in research.

“Public engagement”, “science communication”, and “education and public outreach” are blanket terms covering communication aspects about scientific research to those members of the public who are neither professionals nor specialists in the relevant field. These terms describe the myriad ways in which the scientific community can share its activities and scientific benefits with the wider society. Lewenstein (2015) categorises public engagement under two main aspects: “engagement” as a learning activity and “engagement” as public participation in science (Table XXX). Both have in common that academics and physics-related communities, such as educators, reach out to individuals and society-at-large and engage them with science. Engagement is, by definition, a two-way communication process, involving both listening and interaction, with the goal of generating mutual benefit. “Science communication” and “education and public outreach” are blanket terms covering anything to do with public engagement with science, from its aims to its methodology. Public engagement is, however, an essential tool to build and strengthen public support for research. Indeed, the trend for evidence-based public policy increasingly relies on access to a wide variety of specialists, many based in universities.

Table 2.4.2.1a. Overview of the main categories of public engagement initiatives with astronomy. (based on Bell et al. 2009).

Category	**Characteristics**	**Examples of public engagement activities**
Developing interest in science	Experience excitement, interest, and motivation to learn about science.	● Exhibits (e.g.: IAU's Above & Beyond) ● Media: TV news, newspapers, magazines, etc. ● Social media
Understanding (some) science	● Understand concepts, explanations, arguments, models, and facts related to	● Public talks (e.g.,XXX) . ● Documentaries (e.g., Cosmos,) ● Popular-science

	science. ● Manipulate, test, explore, predict, question, observe, and make sense of science.	books and magazines (E.g.: Seminal Stephen Hawking's seminal book: Brief History of Time[3]) ● Workshops and hands-on exhibitions ( ) ● Public Websites ( )
Using scientific reasoning and reflecting on science	Reflect on science as a way of knowing; on processes, concepts, and institutions of science; and on their own process of learning about phenomena.	● Community and dialogue initiatives (e.g.,)
Participating in the science enterprise	Public participates in scientific activities and learning practices with others, using scientific language and tools Public identifies as people who know about, use, and sometimes contribute to science. Public actively participates in research debates. Public co-design and/or co-implement research questions, projects. Public actively participates in funding research projects.	● Citizen-science projects (e.g., Zooniverse / Galaxy Zoo[4]) ●

Public engagement is an endeavor that takes many forms, ranging from education programmes to citizen-science projects and science festivals. All of these help researchers disseminate the societal benefits of their work while keeping abreast of public concerns and expectations. Public engagement activities provide a platform for researchers to discuss their projects and objectives with the wider public. For optimal benefits these actions must be practical, innovative, research-based,

[3] https://en.wikipedia.org/wiki/A_Brief_History_of_Time
[4] https://www.zooniverse.org/projects/achmorrison/steelpan-vibrations

educational, and feeding each other with ideas, opportunities for research studies, and even financial resources-.

Public engagement helps maximize the flow of knowledge and cooperation between astronomy communities and society, giving researchers the potential to create an impact through learning and innovation. Strategic investment in public engagement helps to maximize this potential by focusing attention and support on how research enriches the lives of people. It also contributes to social inclusion and social responsibility and allows researchers to better respond to local and global social issues with appropriate effective support to people [7]. Building trust and mutual understanding is critical to a healthy higher education and research system [8, 9], especially at a time when deference to authority and professional expertise is decreasing.

Commenté [4]: this is the first time astronomy is specifically mentioned in this section, which is hitherto very generic. Perhaps make a link to the unique role that astronomy has here already earlier in the text

Moreover, the Internet has fostered many astronomy citizen-science projects where the public gets involved in data collection, analysis, or reporting. The low-level access to the scientific process is one key advantage of such projects and the large collaborations generated allow widespread research leading to discoveries that single scientists could hardly achieve on their own [10].

We believe that European astronomy institutions need to provide long-term support to retain the necessary skills, experience, and resources to facilitate communication efforts. It should not add to the existing pressure for publishing and being competitive but be part of the job profile of responsible scientists [15]. We argue that research institutions should not rely on institutionalized science communication to avoid a trench to growth between scientists and communicators.

We do, however, endorse open and public spaces, where innovative science communication can take place. Such ”Idea Colliders” [16] have the chance to supersede traditional science museums and promote critical scientific thinking and decision making. These spaces can trigger debates in an interdisciplinary setting involving scientists and citizens from diverse disciplines, including those from the cultural, political or business sectors.

We find ourselves in challenging times. Modern challenges are complex, broad, global, and deeply rooted in societal dimensions. The climate crisis and the current COVID-19 pandemic are just symptoms, but with connected causes. Our roles and responsibilities as astronomers are changing at the same speed as the environment changes – an environment that we have described and tried to understand for decades. The knowledge we gained in that process should help for fast progress in preserving our environment (or nature) but can no longer remain the exclusive property of specialized research fields. Open communication among scientists, across disciplines, and with society (Public Engagement) is crucial on our way towards the futurefututo. While these communication efforts are key to meeting

global challenges, their success depends naturally on a functioning science-society relationship: a difficult task in a rather unstable world, politically, socially and economically.

Present times demand a culture in society that appreciates [33] and trusts [8] science; understands the scientific process as a probabilistic approach and the concept of uncertainty in the interpretation of scientific results [21], differentiates between scientific uncertainties and low-quality or doubtful science [34], disregard the negative connotations of the term “uncertainty” [35]; makes scientifically motivated decisions and seeks a dialogue with researchers

We encourage our colleagues from all fields of astronomy to appreciate the increasingly challenging needs of our society, scientists included, and to engage in the exciting communication landscape.

Recommendations:

- Astronomy education and public engagement needs to be viewed as a long-term community investment, not as a grant requirement or an option for public relations/marketing.
- Ensuring that 2% of the budget for funding research is devoted to education and engagement with the public;
- Expand the recognition and award of researchers to include education and public engagement in their career paths;
- Astronomy education needs to follow research: include cutting edge science & global competence framework.
- The design, management, and evaluation of all programs using best practices is critical.
- Astronomy education and public engagement should not be an afterthought for large projects; planning for educational efforts should begin with the planning of the project.

Commenté [5]: Perhaps also adding the challenge that science and facts are considered by a growing(?) number of people as just views and opinions.

Commenté [6]: Perhaps add a number here: e.g., 10% of a big science project should be reserved for engaging the public in a professional way (as e.g., NASA is doing)

4. Astronomy for Sustainable Development

Astronomy is an innovative and cost-effective tool for furthering sustainable global development because of its technological, scientific, educational and cultural dimensions. The role of scientific knowledge remains central to sustainable development (OECD 2020). However, research fields, like astronomy, must be conceptualised broadly to include not just natural and technical sciences, but also knowledge from the social sciences, arts and humanities as well as practical and non-technical knowledge, and experience (Schneider 2019). We need to learn to re-adjust and re-balance the interactions between these disciplines to increase the contribution of astronomy to sustainable development (ISC-UNDP 2020).

The European astronomical community needs to harness the skills, infrastructure and knowledge of astronomy to benefit society at large by:

Strengthening collaborative networks to coordinate SDGs-related research and practice efforts across Europe and internationally: The European community needs to facilitate collaboration among the global network of researchers and development professionals, educators, communicators, policy-makers and industry representatives and share European expertise and knowledge with the broader community. This ensures smaller European groups and initiatives can participate in a research-practice network, where experiences and different perspectives regarding this topic can be shared.

Consolidating and stimulating SDG-targeted actions in society through astronomy at European and international levels, namely through the IAU European Regional Office of Astronomy for Development. -The IAU European Regional Office of Astronomy for Development needs to facilitate transdisciplinary collaborations to address SDG-related challenges within the field of astronomy. And further the development and implementation of innovative practices and actions of sustainable development within the astronomy community. For example, by using the cosmic perspective as a tool for fostering respect for cultural diversity and climate education, building on educational concepts such as Global Citizenship Education (GCED) and Education for Sustainable Development (ESD), and learning tools such as “the Pale Blue Dot” inspirational picture and respective educational programme. These approaches have been highlighted by the work of D. Attenborough (2020), Horvat, S. (2019) or Zaki J. (2019), the recent UN75+ Dialogue on Astronomy - a Unique Educational Tool for furthering the SDGs and Stimulating a Global Perspective and align with UNESCOs educational approach,- (SDG 4.7 and SDG 13.3)

Efforts to integrate the SDGs in astronomy research and practice have already begun across astronomy (Alves-Brito et al. 2019). Some specific SDGs that astronomy can directly contribute and tackle are:

Climate Action: environmental sustainability of the astronomy practice, following the research and recommendations from several publications (Stevens, A.R.H., et al. 2020; The climate issue 2020; Williamson, K. et al. 2019) organisations such as UNESCO, and communities such as Scientists for Future and Astronomers for Planet Earth (SDGs 12 and 13), in accordance with the European Green Deal.

SDG: 11**:** Threats to Dark and Quiet Skies: through the IAU, the astronomy community have been working closely with UNESCO to safeguard astronomy-relevant world's cultural and natural heritage, from historical sites to the dark (and radio quiet) skies. The European astronomical community needs to address the rising light pollution, including the emerging threat of increasing numbers of satellite constellations to astronomy research. (SDGs: 11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage) (for example Serjeant, S. et al. (2020) and Rawls, M.L.et al. (2020)).

Gender equality: While progress has been made in recent years, significant gender imbalance still exists within astronomy as a profession. Following the IAU's initiatives to formalise individual efforts to boost women in astronomy, Astro4SDGs will work towards gender equality and the empowerment of women within the astronomy community. The European astronomical community needs to develop specific training to researchers and advocate for equity and inclusion in STI fields. The activities will be based on the recommendations and plans developed by Horizon 2020's project Supera and ASTROMOVES and the IAU, which and are in line with the European Union's policies on Inclusive Societies. (SDGs: 5: Gender Equality and 10: Reduced Inequalities).

Inequalities: there is a significant imbalance in the inclusion of underrepresented and vulnerable groups (persons with (dis)abilities and persons with racial, ethnic, religious, LGBTQI+ backgrounds). The European astronomical community needs to be inclusive by training researchers and advocating for diversity and equality in STI. Institutions will better understand how to create structures that support and nurture talent from minority groups, developing appropriate policies and procedures within their faculties to facilitate recruitment and retention of talent from these groups in astronomy. This could follow some of the work done by international research organisations such as USA-based Association of Universities for Research in Astronomy and Berkeley's Division of Equity & Inclusion (SDG 10: Reduced Inequalities)

Recommendations:

Commenté [7]: these are all valuable, but generic. What can astronomy do here it the context of its impact and influence on public etc, e.g., a zero emission ELT, SKA? Green supercomputing?

- European astronomy (community) should (at the very least) follow the European timeline towards carbon-neutrality: 50% reduction of CO_2 emissions by 2030 and 100% by 2050
- Institutions need to develop environmental footprint assessments and respective reduction plans, which includes several aspects of astronomy: Construction and management of facilities; travel and computing
- Astronomy community needs to support education and public engagement activities in climate education.
- Although the various funding agencies and organisations have supported programs, that promote diversity and inclusion in astronomy, they have not made diversity and inclusion central parts of their funding strategies and plans .
- It is important to coordinate data collection with standard metrics, the lack of such data has prevented departments from making meaningful comparisons – and actions.
- The best way for astronomy to make progress as a field toward diversity and inclusion is through a combination of top-down actions by funding agencies and EU-level astronomy organisations and Universities, and bottom up actions by departments and institutes. Diversity and inclusion should be not only our goals, but also principles to embody in the change process.