The contribute of Civilian Space Development to sustainable development on Earth and in outer space. The private space development and economic growth.

A proposed session for UN General Assembly 78, September 2023, organized by Space Renaissance International, in collaboration with ACES Worldwide

Ver. 1.01 – 02.11.2022

1 A necessary disambiguation of terminology

Civilian space development and Private space development are strictly interconnected, and mutually supporting, yet they are not exactly the same thing. A proper disambiguation is necessary, in order to properly understand the different areas of interest and stakeholders.

Private Space Activities (PSA) are developed by private corporates, based on private investments. In the New Space eco-system, private corporates may work both for private customers and for government agencies.

Civilian Space Development (CSD) is a broader concept, since it encompasses initiatives funded both by public money, through government agencies, by private investments or a mix of public and private investments.

Discussing civilian space development is equivalent to discuss space settlement, i.e. civilization expansion beyond the boundaries of Earth's atmosphere, into outer space. It can also be intended as an extension of civilian activities and civil rights outside Earth, in the immediate surroundings (Geo-Lunar space region), towards Mars orbit, the Asteroid Belt and beyond.

Civilian activities are also meant to be distinct from space exploration, that is a military activity, made by trained astronauts. Civilian space passengers are intended as normal citizen passengers, traveling by airlines or passenger ships. "Civilian" is opposed to "Astronaut", that was so far a trained military and, in the future perspective, will be personnel serving on space vehicles, just like, in civil aeronautics, we have professional personnel (pilots, hostesses and stewards) and civilian passengers.

In the 2022 scenario, space tourists can be considered the first civilian space passengers, though they still need a light training, due to the not completed transition of the space vehicles from the mission requirements of space exploration to the ones of passengers transportation.

The term "civilian" is particularly stressed, in order to denounce the huge delay in the development of proper scientific research strands, targeted to protect life and health of civilian (i.e. normal, non military, non trained) space travelers and, just one step further, space workers and space residents.

Our political focus will be more effective as it will use the proper terms, which are self-explaining and self-motivating.

2 Justification and scope of the proposed session

On 25 September 2015 the governments of the 193 Member Countries of the United Nations signed an Agenda of 17 Sustainable Development Goals to be achieved within 2030. And the UN General Assembly approved the Agenda. The keyword of the Agenda was "sustainability" of human civilization further development.

The key critical themes faced by the UN Agenda 2030 were the following ones:

- **Social and Economical Growth Goals** (SEG): SDGs 7, 8, 9 concerning energy, jobs and industrial development
- **Human Life Goals** (HLG): SDGs 1, 2, 3, 4, 5, 6, 10, 11, 16, related to poverty, hunger, health, education, water and sanitation, gender equality, inequalities, urban env and communities, peace and justice
- **Earth Environment Goals** (EEG): 13, 14, 15, focusing climate, life below water and on land
- **Methodology Goals** (MG): 12, 17, about responsible consumption and partnerships for the goals

All of the 17 SDGs are perfectly shareable, from a humanist point of view, by the Planet Earth's good willing people, aimed to assure a sustainable continuation of our civilization.

Yet, as soon as the Agenda was published, some relevant criticalities appeared.

First of all, the general criteria supporting the concept of sustainability developed by the agenda is an unquestioned limitation to the boundary of Earth's atmosphere. Outer space was not considered at all, as a dimension that could help to increase the sustainability of human development.

In July 2018, at UNISPACE+50 conference in Vienna, Space Renaissance held a short speech about such a discrepancy (by Adriano V. Autino, SRI President at that time). Here's a conceptual summary of that speech: "Humanity is facing three main challenges. The first one is the so-called save-the-planet initiative, many goals of the 2030 agenda include these goals, climate change in primis. The second challenge is space exploration, that will maybe take us to Mars with a first expedition. The third challenge is to save the civilization. Our analysis at SRI is that this third challenge is disattended and neglected, because eight billion terrestrials cannot save their civilization if they will not begin immediately to expand into space. Expansion of civilization into space is different wrt space exploration. Exploration can be done by trained astronauts, able to bear acceleration of 4-5G, and to face hard and dangerous re-enter in the atmosphere. So, what we need, if we want to carry civilian passengers into space, is a full change of paradigm in the mission requirements. If we want to travel, work and live in space we have to be protected from cosmic radiation, we need simulated gravity, to avoid the problems for health etc., low acceleration, safe reenter, etc. A full change of paradigm. I would like to see not only the space tourism branch to face this problem. I would like to see many other industrial, commercial and governmental branches to be aware of this challenge, to save our civilization from a possible implosion caused by the many problems that we have on this now small planet."

End of 2022, while we are planning sessions for UN GA 78 2023, the awareness about the potential of space in support of a sustainable development in general terms seems to be increased, thanks to some space advocacy groups and organizations which are active inside the UN Institutions, namely in its Space branch. At least, the use of space technologies and space resources *on Earth* seem to have conquered a better place and consideration, in the above mentioned UN space branch. See this page "Space Supporting the Sustainable Development Goals", on the UNOOSA website[1].

For the immediate future, in order to enhance awareness and programmatic efforts, we see at least two major issues.

a) The UN space branch – UNOOSA, COPUOS – should break the thin but hitherto impermeable diaphragm that keeps space topics out of the UN public talks to the general public opinion

b) The immense and decisive contribute that civilian space development can give to sustainable development in general, not only on Earth's surface, but also, and mainly, in outer space should be added, communicated, promoted and developed in the UN space policy. We are talking about civilization expansion into outer space, space settlement and industrialization, starting in the Geo-Lunar space region, Earth and Moon Orbits, and Lagrange Libration Points.

This paper tries to summary illustrate the complexity of *private space development and economic growth*, and to suggest some priorities, in such a perspective. In fact, what is the main scope of UN? To recommend priority research strands and strategic directions where to concentrate both research efforts, private investments and public (governmental) actions, to support and encourage collaborative and competitive initiatives worldwide.

For the sake of measurability of the efforts during next years, we also are providing a rudimental compliance matrix, among the proposed activities and the SDGs. As a warning: not easy to have a *quantity measurement* of big social and environmental processes, though it will not be too hard to get *quality assessments*. Some relevant socio-economic and cultural KPIs can be easily assessed and related to the ongoing space development (if any), e.g.:

a) Will global economy be growing or declining? With which percentage rates?
b) Will global jobs count be growing or declining? With which percentage rates?

[1] https://www.unoosa.org/oosa/en/ourwork/space4sdgs/index.html

c) Will young generations have a more enthusiastic engagement in their studies, researches, entrepreneurial efforts, both in industrial and emerging countries?
d) Will the geo-political tensions and conflicts be declining, thanks to the opening of the new horizon of development in space?
e) Will people get more confidence in the future? Will culture and arts reflect the new climate?

3 The 17 SDGs revised hierarchy

Now, analyzing the 17 SDGs versus their sustainability, we can immediately observe that the Social and Economical Growth Goals (SEG) SDGs 7, 8, 9 are the key pillar, sustaining social, economic and cultural growth, thus all of the Human Life Goals, and the Earth Environmental Goals: without industrial development poverty, hunger, health, education and sanitation cannot be enhanced. Gender equality cannot be pursued, social inequalities cannot be reduced. There will be no resources to improve urban environment and communities. In an environment of poverty and social fear, peace and justice will remain a dream, an utopia. The environmental goals, as well, cannot be pursued in a context of declining industry and technology. In Figure 1 a schematic representation of the sustainability pyramid, as presented by A. V. Autino at the UN GA 77[2].

Figure 1. The pyramid of sustainability

However, the big issue is really about the sustainability of the three pillar goals. And it is easy to reply: if limited within Earth's atmosphere boundaries, the key pillars are NOT sustainable. The main conflictual factors encompass energy at first place. Energy demand will increase manifold due to the further development of the web society and the electric mobility. Btw, the raise of web communication and entertainment technologies is advocated by de-growthist propaganda, in order to discourage general mobility. The survived mobility should fully convert to electrical feed. Yet, the rising production of electronic devices for communication/entertainment and components for electric cars requires rare earths and other materials which are critical to be found on Earth. SDG 15 calls for a reduction of use of paper. Yet, the less we will use paper, the more we will need electricity. Culture is now largely based on electronic media: should we surrender and use less electricity, our culture could revert to stone age. Furthermore, the global consumption of Earth resources, starting from agricultural land to the overload of all the recycling systems, is the big problem. The "Earth overshoot day" is coming earlier each year. Each year, we are consuming the resources of 2 planets Earth, and that is the real challenge of sustainability. The Wars for oil (not yet archived by history) are now accompanied by wars for rare earths. Pollution will be increased by disposal of batteries and technological wastes. Oceans are already over-exploited and intolerably polluted. Not to mention the big social issues of the closed world, such as pandemics and several serial economic crises.

4 The urgent need to add an 18° SDG: bootstrapping Civilian Space Development before 2030

In general terms, the sustainability of the 7th, 8th and 9th SDGs is the real challenge. Expansion is indispensable, to avoid any de-growthist drift: degrowth would kill human freedom, culture and social

[2] https://youtu.be/XQVHVkn3CiM?t=1787

nature. If confined in a cage, democracy will be crushed among nationalism, sovranism and neo-authoritarian feudal powers. A transterrestrial society[3] shall begin to exist: a horizon of expansion that will restart social growth, hope in the future and civil growth. The transterrestrial economy may include Earth orbit and the Geo-lunar space region, that was also called the Greater-Earth, a sphere 3 millions km wide, corresponding to the Earth's gravitational influence: "This sphere, with a diameter of 3 million kilometers, has 13 million times the volume of the physical Earth and through it, passes some more than 55,000 times the amount of solar energy which is available on the surface of the planet. In addition to energy, within this sphere are enormous amounts of other resources, including the Moon and occasional passing asteroids."[4]

The only sustainable development, for 8 billion people, is beyond the limits of Planet Earth, expanding into the transterrestrial region, taking profit of its enormous resources. A transterrestrial economy will not cut the umbilical cord with the mother planet in short time, it will sustain both the planetary and the extra-planetary communities, yet it will start developing civilization outside Planet Earth. Doing that, the transterrestrial economy will progressively relief Earth environment from the burden of the industrial development. In such perspective, significant progresses on the environmental SDGs (13, 14, 15) will be measured in due time. Since the experience with first space habitats will begin, experimenting small artificial ecosystems in space, we will also learn more about a better management of ecosystems on Earth surface. See in Figure 2 the pyramid of Really Sustainable Development Goals (RSDG).

Figure 2. The really sustainable development goals

As KPIs, we could measure the real effectiveness of Civilian Space Development on general sustainability, checking the following questions, let's say, in about 20 years (2045):

f) Has our civilization survived the devastating multiple crises of 2020's?
g) Was the most part of human patrimony conserved?
h) Is demographic growth moderately positive?
i) Was a global implosion of civilization avoided?

5 A raw compliance matrix, among civilian space activities and the SDGs

Hereafter, in Table 1, an initial compliance matrix, among civilian space activities and the UN 2030 SDGs, showing the incomparable superiority of space vs. terrestrial industry. In the table, only the directly affected SDGs are mentioned. All of the other SDGs should be considered indirectly affected, in cascade, by the improvement of the directly affected ones.

[3] The concept of "transterrestrialism" is due to Dr. Marie-Luise Heuser, Head of the Space Renaissance Academy Space Philosophy Laboratory - https://youtu.be/-hpu91QNklM
[4] https://greater.earth/GEO_DOCS/a_new_perception_of_our_planet.php

Activity	Factors of Sustainability	Benefits	SDGs
Space Transportation	- Zero gravity, zero attrition	- Very lower cost, vs. terrestrial transportation	8, 9
Space Engineering	- Zero gravity, zero attrition	- Very light structures required, vs. terrestrial ones. - An orbital power plant can develop in volume, instead of area. Very less wear and tear.[5]	7, 8, 9
Space Power	- No seasons, no weather changes, - No space limitation for panels	- Energy production yield very higher vs. terrestrial yield, 1400 W/m2, 24/24, 365/365 - Unlimited surface for panels, with zero consumption of soil - Energy produced in space, zero thermal burden inside atmosphere - Unlimited light, warm and comfort in space habitats	7, 15, 13, 3
Asteroid Mining	- Great abundancy in the Solar System - Agglomerations of materials, big and small rocks, kept together by small gravitational field - Almost pure materials - Precious metals: gold, platinum, nickel - Many NEAs have a low Delta-V - Possibility to be digged inside	- Asteroids don't require complex refining processes - easy to be reached - easy to be mined - abundant precious metals, to improve quality and performance of electronics - construction of space habitats inside asteroids, with simulated gravity and protection from cosmic radiation - products: raw materials for fuel, various industries, life sustaining components	8, 9, 11
Moon Mining	- an environment similar to Earth, near Earth - a giant test facility, to experience space - vacuum and reduced gravity - Moon gravitational well is 1/20 of Earth - abundance of in situ resources and water	- Some Moon industry products: sheet metal and trusses of aluminum, magnesium, titanium, iron, or alloys; castings, bars, wires, powders of pure or alloyed materials; glasses; glass wool; ceramics; refractories; fibrous and powdered ceramics; insulation; conductors; anodized metals; coatings, including almost perfectly reflective sodium coating; thin film materials; silicon chips; solar cells; entire structures of various metals and alloys for lunar and orbital installations[6]. - Helium3, a component required for nuclear fusion, very rare on Earth	7, 8, 9
Space Farming	- hydroponic cultivation in volume, in zero, low normal (simulated) gravity - zero parasites - zero illnesses - zero damage - unlimited space for cultivations - unlimited solar power - unlimited basic raw materials	- very high crop yield, vs. terrestrial - higer number of fruits - bigger volume and weight - zero waste - lower energy demand - lower water demand - water use higher efficiency - lower fertilizers and nutrients demand - abundant offer of food, at low cost, both in space and on Earth	7, 8, 9, 2, 11, 12
Orbital Debris	- orbital debris represent an already sustained cost - an abandoned value, that can still be used	- claiming Earth orbit from debris, dangerous for space navigation - reusing recovered debris as resources for building of space infrastructures - it may be the first manned industrial activity in Earth orbit	8, 9
Space Maintenance and Transportation	- assembling satellites in orbit reduces the need for automated deployment devices - maintenance of satellites in orbit allows to use off-the-shelf parts and subsystems - satellites delivery and relocation service reduces costs as well	- decrease the cost of design, development and launch of satellites	8, 9
Fuel Production in Space	- producing and selling fuel in space reduces the need to bring all the needed fuel from Earth	- decrease the fuel produced on Earth	8, 9, 13, 14, 15

[5] Gerard K. O'Neill, "The High Frontier – Human Colonies in Space", 1976, Bantam Books, Inc.

[6] Ehricke K. A. (1985) "Lunar Industrialization and Settlement-Birth of Polyglobal Civilization"

Activity	Factors of Sustainability	Benefits	SDGs
		- meaningful downsize of the cost of any space travel - boosting the space economy	
Space Industry	- developing space industry will progressively reduce terrestrial industry - space industry will boost the global transterrestrial economy - microgravity allows development of products that cannot be produced in normal gravity	- huge global economic and social growth - creation of millions jobs, on Earth and in space - creation of new industrial segments and new markets - development of many new products in microgravity - progressive reduction of the demand for energy on Earth surface - progressive reduction of pollution on Earth land and sea - progressive transformation of Earth in a beautiful natural garden - space economy to lead global transterrestrial economy within 2040 - the space economy revolution will progressively reduce and make obsolete wars on Earth	7, 8, 9, 13, 14, 15, 16, 12
Space Habitats	- space habitats will be built using extraterrestrial resources, from the Moon, Mars and the Asteroids - availability of abundant resources, energy and space - possibility to take profit of zero, low and normal (1G) gravity zones	- huge progress in urban development - higher degrees of freedom, to organize day/night, working and sleep schedule, abundant light - new wealth and well being, new sports, arts, entertainment - space real estate will be one of the leading economic sectors	8, 9, 11
Space Tourism	- allows wealthy people to finance the development of space passengers transportation and accommodation technologies - ST is the only industrial segment working to transport untrained civilians in space - ST allows many people to see Earth from space (the Overview Effect) - ST allows many people to start thinking in 3D, generating new entrepreneurial ideas	- potentially self-sustaining industrial segment - improved ergonomics, safety and comfort of space travel - the more people seeing Earth from space, the more people will understand: a) our fragility and need to expand into the Solar System, b) the need to keep the environment of Earth habitable for humans and other sentient species c) the need to steward the natural beauties and residual wild life on Planet Earth	16, 13, 14, 15, 8, 9
Space Safety	- traveling, living and working in space will force to work on protection of life from cosmic radiation and simulated gravity - the second source - mastering our space region	- establishing communities out of Planet Earth mitigates the risk of humankind extinction due to life-ending events, both exo- or endo-generated (the second source) - mastering our space region will allow to better defend ourselves from dangerous impacting asteroids	missing in SDGs
Space Health	- microgravity environment easier for disabled people - microgravity environment easier for curing several diseases	- many disable people to get a better life - microgravity allows a better treatment of several diseases - space hospitals in orbit, Lagrange points and the Moon to enhance health both in space and on Earth - retirement homes in space will be a good place for many elderly people to spend their last days, and to elongate that period - space hospitals and retirement homes will constitute a relevant segment of transterrestrial economy	3

Table 1. A compliance matrix among civilian space activities and the UN SDGs of the 2030 Agenda.

6 A possible development of a Transterrestrial Economy towards 2100

In Figure 3, a conceptual forecast of GDP towards 2050. In such a perspective, we can observe that there will be at least two critical breakpoints.

If the proper space policy decision will be taken during this decade 2020-2030, between 2030 and 2040 we could see the take-off of the transterrestrial economy, that will quickly take the lead of the global economy development, aiming very high. Pure terrestrial activities – such as agriculture, tourism, natural environments care, communications, mobility, will enter a steady or slightly decreasing stage, while the space economy will lead the global economy (Earth+space) to unprecedented growth, reaching at least 1000 $Trillions before the end of the 21st Century. During the last quarter of the Century, the age of Solar Economy will kick-off, when Cis-lunar communities will become self-sustaining, and the Cis-lunar settlement will start consolidating.

Another critical development point will be after 2050, when humanity will really start developing Mars and the Cis-martian space region, establishing Mars as a logistic pole and industrial settlement, towards the Asteroid Belt. Yet, likely, that time will not be characterized by a deep crisis like the one we are facing now, since 30 years of glorious economic and social growth will be sustaining that further development. Earth environment will be seeing the first sights of improvement, and the competition will be fairer, since the great abundance of space resources will be not only dreamed, but really experienced. And humanity will move ahead with less fear, and more confidence in the future.

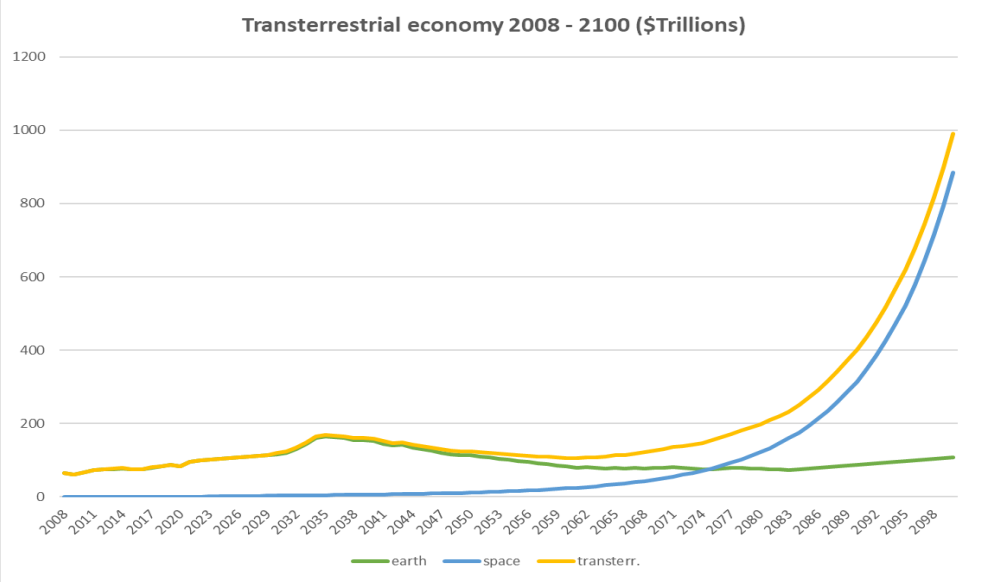

Figure 3. Transterrestrial towards Solar Economy 2008 - 2100