

Summary and Evaluation of the EDEN ISS Public Outreach Activities

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EDEN ISS is a European project focused on advancing bio-regenerative life support systems, in particular plant cultivation in space. A mobile test facility was designed and built between March 2015 and October 2017. The facility incorporates a Service Section which houses several subsystems necessary for plant cultivation and the Future Exploration Greenhouse. The latter is built similar to a future space greenhouse and provides a fully controlled environment for plant cultivation. The facility was setup in Antarctica in January 2018 and successfully operated between February and November of the same year. During that nine month period around 270 kg of food was produced by the crops cultivation in the greenhouse. It is the wish and more often the need for scientific projects to communicate their outcomes not only to the scientific community, but also to the general public. The EDEN ISS project and in particular the experimental phase in Antarctica was accompanied by extensive public outreach activities. Presence in social media, a project website, informative flyers, an experimental toolkit for young students were created in order to engage with the general public. This paper describes the different public outreach activities of the project and also evaluates their effectiveness. For the evaluation, statistics from the website and social media accounts as well as responses to press releases and educational activities are being displayed. Based on the experience from the outreach campaign of EDEN ISS, the paper provides recommendations on how to organize and conduct public outreach activities for scientific projects in space exploration.

Nomenclature

FEG	=	Future Exploration Greenhouse
MTF	=	Mobile Test Facility
DLR	=	German Aerospace Center
CNR	=	Consiglio Nazionale delle Ricerche

I. Introduction

THE EDEN ISS Mobile Test Facility (MTF) was successfully deployed in Antarctica in January 2018 after three years of design, development and construction. The MTF houses the Future Exploration Greenhouse (FEG) and a Service Section which contains the subsystem necessary to run the FEG. The FEG is a space greenhouse test facility with a cultivation area of 12.5 m². A detailed description of the design process of the MTF and its components, plant selection and project development can be found elsewhere.¹⁻⁸

The MTF is located 400 meters south of the German Neumayer Station III (70°40'S, 008°16'W) on the Ekström ice shelf in the vicinity of the Atka Bay. The station is operated year-round with a summer (November to February) crew of 50-60 people and a winter (February to November) crew of 9 people. No resupply reaches the station during the winter period, which means that all supplies (e.g. food, spare parts, tools) need to be delivered during the few summer months. This remoteness makes the Neumayer Station III an excellent test area for human space exploration test missions.

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In 2018 a tenth person complemented the wintering crew to operate the MTF. The operation started in February 2018 and was continued throughout the whole winter season 2018. The first plants were sown on February 7 and subsequently transferred to the cultivation trays in the following weeks. The plants developed very well and the first harvest occurred on the March 20. This harvest included lettuces, radishes, Swiss chard and other leafy greens. The first harvest of cucumbers (March 29) and tomatoes (May 16) followed soon after. The last harvest of the 2018 winter season was executed on November 20. Until then a total edible fresh biomass of 67 kg cucumbers, 46 kg tomatoes, 19 kg of Kohlrabi (a type of cabbage), 8 kg of radish, 15 kg herbs, 56 kg of lettuce, 51 kg of leafy greens and 1.5 kg of sweet pepper was harvested from the plants grown inside the FEG. Most of the produce was consumed by the wintering crew except for a small portion that was set aside for measurements and sampling.

Furthermore, a large number of experiments and measurements have been conducted by the on-site operator (Paul Zabel) which included research in the fields of food quality and safety, microbial environment, horticulture, greenhouse subsystem validation, plant health monitoring, impact of the greenhouse on the crew, electrical energy demand, remote operation and crewtime demand.⁹⁻¹²

The EDEN ISS project team also put a strong focus on dissemination and outreach activities. A wide range of activities was planned and budgeted from the beginning of the project. Table 1 gives an overview about the different activities sorted by means of distribution. The following subchapters describe all activities. Further, the impact of the different dissemination and outreach activities is analysed and numbers are given for number of people reached, press feedback, etc.

Table 1. Overview of dissemination and outreach activities.

	Social Media	Press	Physical items	Educational	Miscellaneous
Activities	<ul style="list-style-type: none"> • Website • Facebook • Instagram • Youtube • Flickr 	<ul style="list-style-type: none"> • Several (>10) press releases • Three press conferences • Photo and video material 	<ul style="list-style-type: none"> • Mission patch • Flyer (2 versions) • Summary brochure • 2 Mock-ups for exhibitions • Banners for exhibitions 	<ul style="list-style-type: none"> • Seed campaign • Lecture material • Live lectures from Antarctica 	<ul style="list-style-type: none"> • Video documentation • Animation works MTF in Antarctica • Animation FEG on Moon or Mars

II. Description of activities

A. Social media

1. Website

The website was the main hub for sharing information about the project. Apart from project related information, presentation of consortium partners, latest news and other basic material was provided including the outcome of the children competition, project animations and videos. A special tool was programmed to allow website visitors to watch the EDEN ISS plants in Antarctica. Each day one could find updated images from 34 cameras which showed how the plants grew. A timeline made it possible to go back in time.

<https://eden-iss.net/monitor/#/container?timestamp=1556575080000>

2. Facebook and Instagram

The Facebook page provides insight into the project under the following link. It also provided visitors with cross-references to other space-related greenhouse, e.g. on ISS or to space-related events.

<https://www.facebook.com/spaceedeniss/>.

Instagram allowed viewers to follow the missions through close-up enticing imagery along the major steps and achievements in Antarctica. Mostly Instagram was used to share photos and videos under the user name: eden_iss_project.

3. Flickr

A Flickr album for the public was established within the DLR Flickr site. It serves as a resource for high-resolution images which can be also used by the press and other media. The album contains 197 photos and is accessible via the following link:

https://www.flickr.com/photos/dlr_de/sets/72157683682719480/

B. Press

Due to the large amount of press releases (15) and the engagement of large research institutions with highly effective communication offices such as the DLR, CNR and others the EDEN ISS project was most successful in

reaching the general public with an estimated number of over 560 million people. The 14 partners collaboratively reached more than 12,000 persons from the scientific community and their peers. Customers and potential investors amount to more than 38,000 persons. The other important group are policy makers and the total amount reached comes to nearly 5000 people. All in all, all relevant stakeholders of such an EU-funded project were reached with a total amount of over 590 million people.

C. Physical items

1. Mission patch

For the Antarctic Mission a special and stitched mission patch was designed and manufactured.



Figure 1. EDEN ISS mission patch.

2. Flyers

Two flyers were produced, one at the beginning of the project in 2015 and one before the Antarctic mission started in late 2017.



Figure 2. Flyer version 2 (2017).

3. Summary brochure

A 91-page executive summary brochure was developed and printed in A5. The brochure highlights the EDEN ISS Future Exploration Greenhouse & Mobile Test Facility, EDEN ISS Crop Cultivation, and Mission: Antarctica, Project Validation, Future Applications and all the Partners. It is available online via the EDEN ISS and partners' websites as a PDF.



Figure 3. Cover of the EDEN ISS summary brochure.

4. Mock-ups for exhibitions

Two mock-ups for exhibitions were designed and built by an external contractor. The mock-ups have different sizes. The smaller mock-up, seen in Figure 4, is meant for short-term exhibitions during conferences and trade fairs. The larger mock-up is used for long-term exhibitions (e.g. museums).

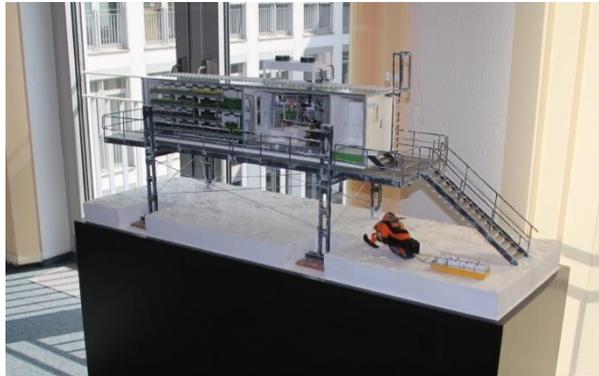


Figure 4. Small mock-up for exhibitions.

5. Banners

For presentation on fairs, two banners were created. The two banners complemented each other with one having an internal view of EDEN ISS MTF as back drop and one banner with an EDEN ISS Antarctica image. Information about the project, yields and the partners were offered.



Figure 5. EDEN ISS complementary banners for trade fairs.

D. Educational outreach

EDEN ISS engaged the next generation of space explorers through an educational outreach program that offered, to teachers and pupils, information and activities related to the cultivation of plants for the purpose of growing food in space, either on the International Space Station or further destinations like the Moon and Mars. Lecture material for schools (age range between 6 and 12 years) and universities was made available.

General information for education purposes see: <https://eden-iss.net/index.php/education/>

For download, two items were offered:

1. Lecture material

PowerPoint presentation for teachers with a lot of images and explanations of the EDEN ISS project and the aeroponic technique https://eden-iss.net/wp-content/uploads/bottlecapdirections_final.pdf

2. SEED CAMPAIGN – Competition for Children

School children were invited to join the Antarctic mission and to submit an original artwork. An open competition for children between the ages 6 and 12 was organized by the DLR. Relevant descriptions, educational kits and entry details were announced through the website and through DLR media portal. On the deadline on the 3rd of February 2019, 87 submissions from Europe had been received.

<https://eden-iss.net/index.php/participate/>

3. Live lectures from Antarctica

The personnel in Antarctica performed live video streaming lectures with classes from the University of Florida, Technical University Munich, Germany and Technical University Dresden, Germany. These lectures usually involved a 50-minute presentation followed by a live view into the greenhouse to show the plant status and 20 minutes of questions from the students.

E. Miscellaneous

1. Video documentation

The video documentary was developed to have a short summary video of the project with enticing video footage. Through interviews with people who worked on the project, the video also shows the diversity of experts contributing to EDEN ISS. The online video documentary explains the goals of the project, how the project came together and how it was tested in Antarctica. It highlights the most important achievements, the way forward and the diverse applications which can be derived from the developed technologies.

Weblink <https://eden-iss.net/> and <https://eden-iss.net/index.php/2019/04/30/eden-iss-project-video/>

2. Animation EDEN ISS MTF in Antarctica

The animation counts 15,536 views since April 2018 up to the delivery of this document.

<https://www.youtube.com/watch?v=fix7jrdfaHE&t=90s>

3. Animation EDEN ISS adaptation on Moon and Mars

An animation was developed, depicting how the EDEN ISS MTF could be adapted to future mission components for lunar and Martian bases.

<https://www.youtube.com/watch?v=KOeSlwwuvWQ>

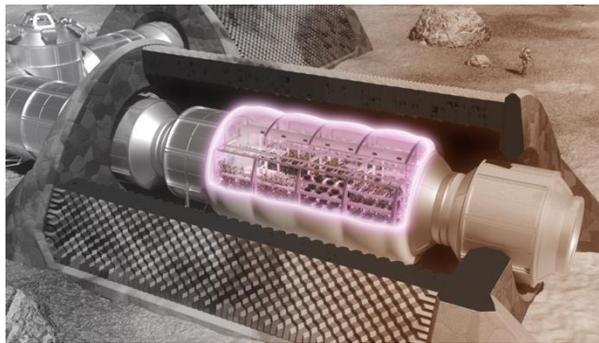


Figure 6. EDEN ISS on moon Mars, representative image for animation.

III. Impact of activities and media analytics

A. Impact of online activities

1. Website

The website traffic was monitored through Google Analytics. In the following summary graphs from the overall visits, it has to be noted that all numbers should be viewed rather as tendencies than as hard figures.

The highest peak of around 2000 visitors was observed on 6 April 2018 which was the day of the press release about the first harvest in the EDEN ISS greenhouse – see Figure 7.

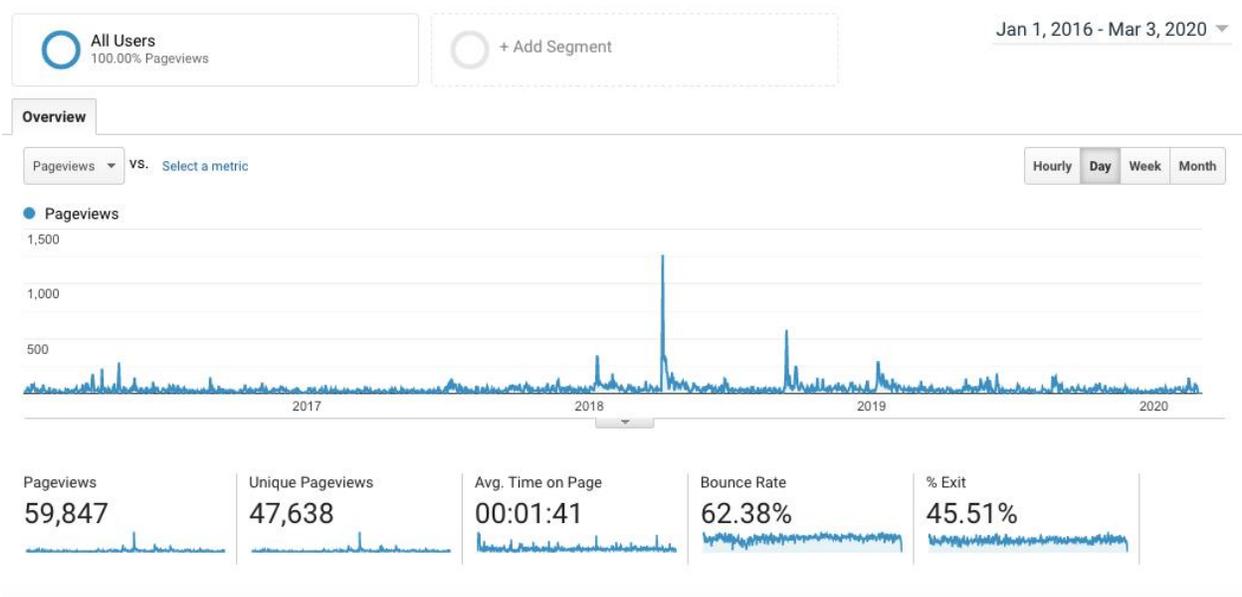


Figure 7: Number of website visitors - between January 1, 2016 and March 3, 2020.

2. Facebook

Social media was mostly covered through Facebook (<https://www.facebook.com/spacedeniss/>) and Instagram and all partners' respective social media pages and postings. The current number of Social media interaction amounts to 187, including one Facebook entry every 2 weeks during the Antarctic Mission. DLR, however has their own additional channel and tweeted about EDEN ISS milestone achievements. So the numbers indicated here are not the total numbers.

The EDEN ISS Facebook page had almost 2,500 likes by the end of the project, see Figure 8. The lifetime total reach of the individual posts range from a few thousand to more than 20,000 people. One post, a video from inside the container in September 2018 showing the status of the plants, even had a reach of more than 120,000, see Figure 9.

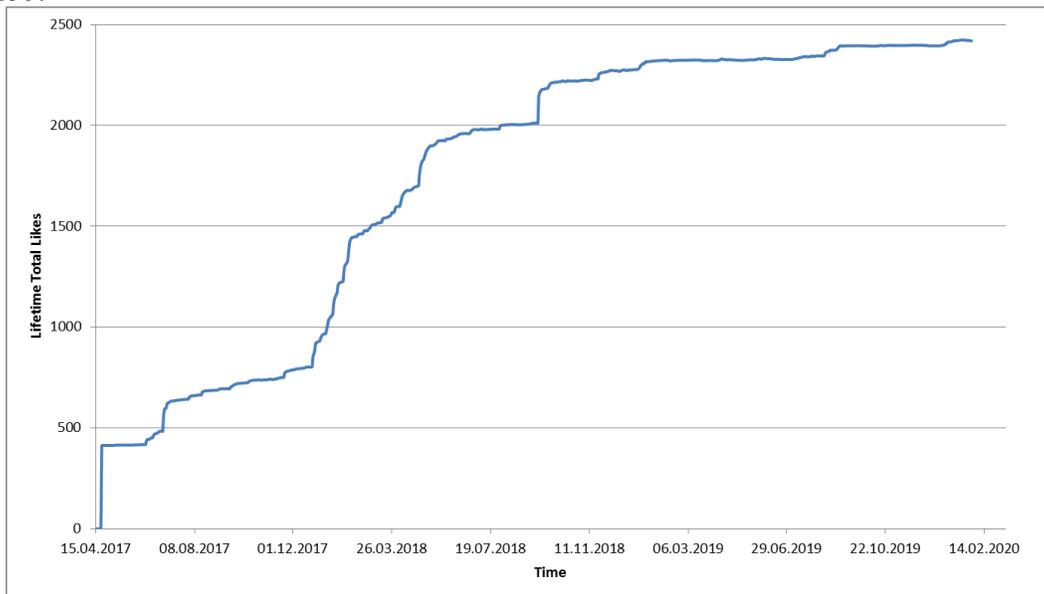


Figure 8. EDEN ISS Facebook page lifetime total likes.

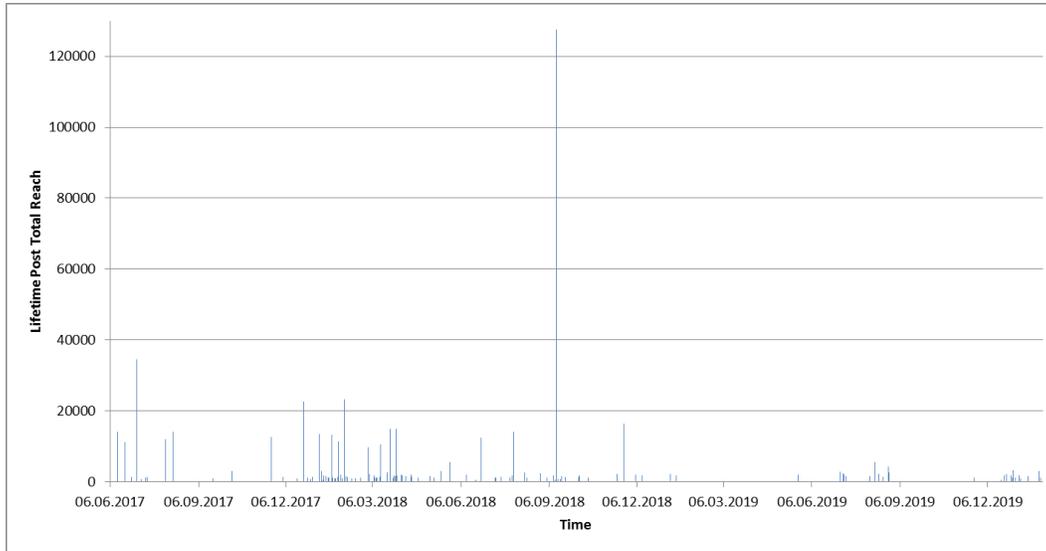


Figure 9. EDEN ISS Facebook lifetime post total reach.

3. *Instagram*

The Instagram page has 1,543 followers (status as of 04.03.2020).

4. *Flickr*

The Flickr album has 2,615 views (status as of 28.02.2020).

B. Media analytics

During the project time, DLR analysed media reports including the ones connected to EDEN ISS. In the timeframe of the EDEN ISS Antarctic mission and before, in the preparation time, media reports got more and more frequent. The number of articles researched by DLR in 2017 – 2018 amounted to 1,890, see Table 2, and these potentially reached a total amount of 561,990,191 people*. Because press releases were sent to international press agencies who distributed the information the articles became nearly untraceable and the numbers shown should only be interpreted as the minimum. The real number of articles is most likely higher.

Table 2. Summary of articles in media.

Type of media	Timeframe	Number of articles
Online	2017 – 2018	1,267
Print	2017 – 2018	512
Radio	2017 – 2018	77
TV	2017 – 2018	34

C. Physical items usage

The physical items were handed out to the consortium partners so that they can distribute them to colleagues, project partners, students, etc. In total 1,000 stickers with the project logo, 150 stitched patches, 2,000 flyers and 300 project brochures have been distributed to people interested in the project.

The mock-ups and the banners were used for several national and international workshops and conferences. The most prominent conference where EDEN ISS was displayed was the International Astronautical Congress (IAC) 2018 in Bremen, Germany with 6,550 registered attendees and 13,000 additional visitors in the exhibition hall on the public day (<https://www.iac2018.org/>).

*People reached is a typical measure in analyzing media coverage and refers to the amount of people that had the chance to view or read an article or social media post about EDEN ISS, because they are following social media accounts or certain TV channels or read newspapers that publicized articles about EDEN ISS. This does not mean that those people actually did view or read about EDEN ISS, because this is impossible to track

D. Educational outreach acceptance

The lecture material website was accessed roughly 1,500 times, but it was not tracked whether the material was actually used.

In total 87 drawings from kids in Germany and Italy have been submitted to the SEED CAMPAIGN Competition for Children. An example is shown in Figure 10.

The live lectures with university students had a very high attendance and each of the three lectures reached approximately 50-100 students.



Figure 10: Example of a submission to the SEED CAMPAIGN drawing contest.

E. Impact of miscellaneous activities

DLR promoted on their website the videos and animations created as part of the project thus over 20,000 people viewed the media. Further the video links have been distributed through Social Media extensively to increase the impact.

IV. Discussion

The outreach success of the EDEN ISS project is due to an overall concerted effort by all 14 partners and a carefully devised outreach strategy which included as described above a multitude of material (physical and digital), means (Social Media, Press Releases and conferences, student workshops, science conferences etc.) and media (videos, photos, print media). All in all, 560 million people have been reached. Five factors were instrumental to the success of the project:

1. A tangible, visible and operative outcome (greenhouse) in one of the remotest areas on earth (Antarctica).
2. A topic that concerns everybody: fresh vegetables. Food is one of the most important essentials to human life and part of everyday conversations.
3. A potent lead partner with a highly effective communication office, the German Aerospace Center DLR.
4. Numerous partners from Europe and the US that communicated the outcomes of the project into their native languages.
5. An extremely pro-active communication work comprising of effective information distribution to the print and broadcasting media and to a variety of press agencies.

These five factors led to a snow ball effect that created this hype around the project and its protagonists. The DLR distributed news about EDEN ISS regularly through press campaigns which reached over 560 million people. Further, European astronaut Alexander Gerst publicly supported the EDEN ISS mission and Social Media contributed to the impact of reaching such a high amount of people. Through partnering with the University of Florida the impact in the USA could be increased (28.5 million people reached through National Public Radio broadcasts). All these efforts viewed together as a dense network of activities, outreach and dissemination efforts created the success of the EDEN ISS project.

V. Summary

EDEN ISS was a huge success in terms of collaboration among international partners, scientific outcome and public outreach. A modern space greenhouse analogue test facility was designed and built in just two and a half years. The facility was then deployed at the most remote continent of Earth, Antarctica, for a first 12-month

experiment campaign with an extension of two other winters (2019 and 2020). During these years, the project partners evolved several aspects related to space greenhouses such as subsystem performance and engineering, horticulture in controlled environment, human factors, plant health monitoring, microbiome in greenhouses and food quality and food safety. The project team put a lot of emphasis on public outreach activities, which reached a huge amount of people all around the world.

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