



# HIGHLIGHTS 2015

YEARLY STATUS REPORT  
EDEN INITIATIVE





The Neumayer III Antarctic station

## EDEN – THE YEAR 2015

- 40 °C, heavy snow storms, high wind speeds (~30m/s), total isolation, and six months of almost complete darkness throughout the day. These are only some of the challenges the EDEN team will face during its EDEN ISS space analogue mission, which will start at the end of 2017 at the German Neumayer Station III in Antarctica. It is this human mission that drove and motivated the EDEN team during 2015, the first year of this EU-funded project.

With a kick-off meeting in March and a detailed two week design study in September, the EDEN team was heavily involved in design tasks for the Antarctic Mobile Test Facility. With this project, the team is on the forefront of pushing the development boundaries of plant cultivation in space. In early 2015, the EDEN Laboratory was extended by an additional room. This new work area offers space for multi-purpose work tables, additional storage area, a 3D-printer station for advanced prototyping, and a small electronic work station.

2015 was also a year for terrestrial applications. In close collaboration with the Association for Vertical Farming (AFV) and leading scientists from the horticulture sector, the EDEN team conducted its second Vertical Farming study, performed in the Concurrent Engineering Facility (CEF). This advanced farm represents a benchmark design for the future discussion on the applicability of inner city agriculture solutions.

In 2015, the 'EDEN for Kids' learning- and outreach program was created in close collaboration with the DLR School\_lab. With this comprehensive teaching program, the foundation was created to facilitate the challenges of space exploration and sustainable living on Earth.

Furthermore in February 2015, Vincent Vrakking joined the EDEN group as a new team member. Vincent, who already conducted his master's thesis at DLR Bremen on inflatable greenhouse systems, complements the team with his essential knowledge of computer aided design and systems engineering. In September 2015, Chen Dong, a Chinese guest scientist, who lived 105 days in the Chinese habitat „Lunar Palace 1“, commenced a one year exchange program with the EDEN group.

The EDEN team is confident that it will continue its development pathway into 2016 and foresees the steady support of its partners and DLR itself.

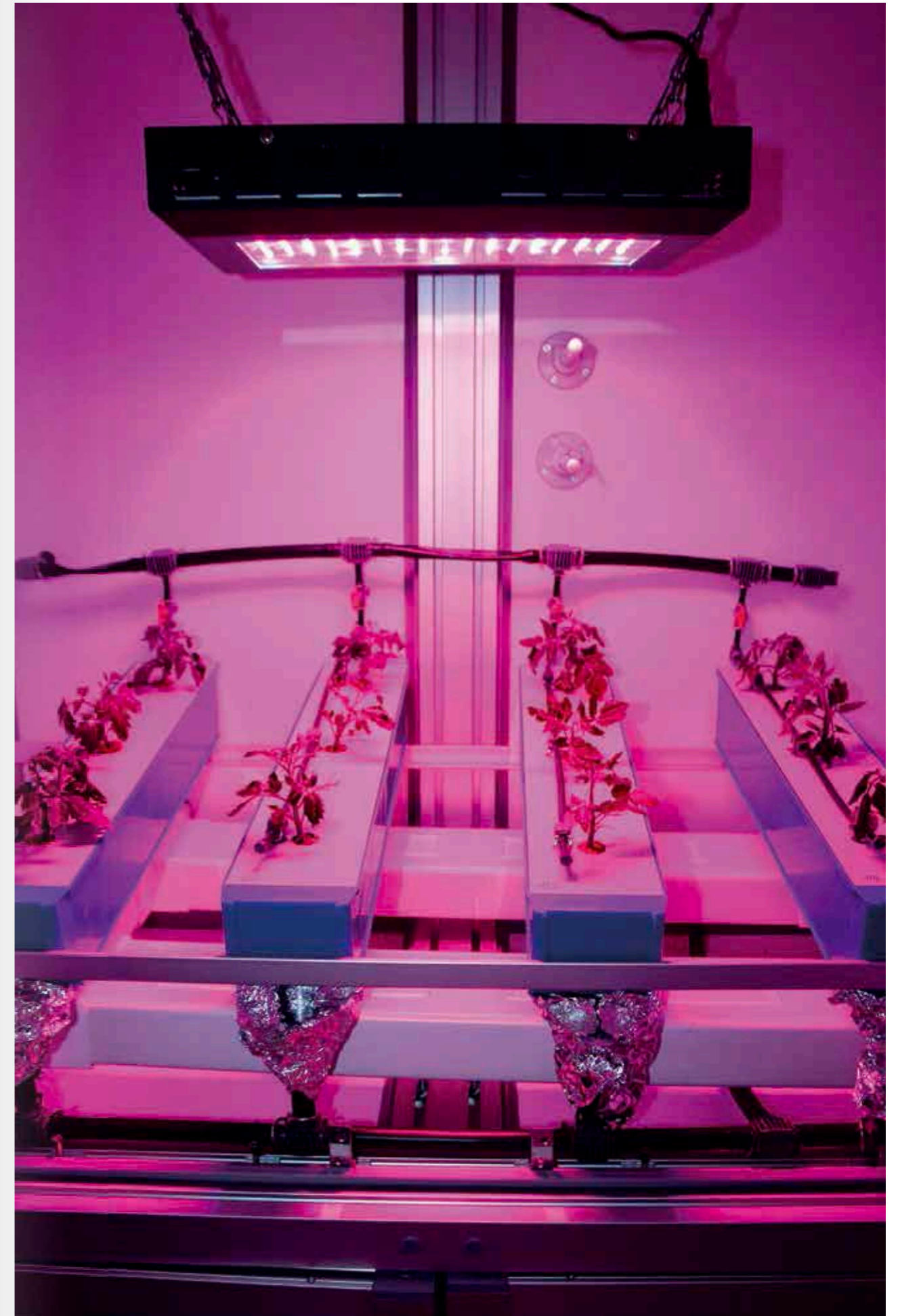
Daniel Schubert





Paul Zabel tending to cucumber plants in the EDEN Lab

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MicroTina growth trials in the EDEN Lab as part of the DLR C.R.O.P. project





## THE EDEN INITIATIVE

In 2011, the DLR Institute of Space Systems launched its research initiative called EDEN: Evolution & Design of Environmentally-closed Nutrition-Sources. The research initiative focuses on Bio-regenerative Life Support Systems (BLSS), especially greenhouse modules, and how these technologies can be integrated in future space habitats.

EDEN was established within the DLR internal project CROP (Combined Regenerative Organic-Food Production) – a joint research endeavor between the Institute of Aerospace Medicine (ME) and the Institute of Space Systems (RY).

It is the goal of the EDEN team to further advance the latest cultivation technologies and to adjust these developments into space related applications. Even though present scenarios for future human missions to Moon and Mars are still several years from coming to fruition, the time to develop these technologies needs to start today. Only this way, highly-reliable and resource-efficient BLSS will be ready for implementation into the mission architecture for humanity's journey to the Moon and Mars.

The EDEN Initiative is administered by the Department of System Analysis Space Segment (SARA) at DLR Bremen. The department operates the institutes Concurrent Engineering Facility (CEF) as well as the Space Habitation Plant Laboratory (EDEN Lab). Furthermore, the EDEN group receives support from the institute's Electronic Laboratory (E-Lab), and utilizes the institute's laboratory building (incl. integration hall) in order to foster the development of cutting-edge plant cultivation technologies.



DLR Institute of Space Systems, Bremen (Germany)



Matthew Bamsey making up hydroponic nutrient solution within the EDEN Lab analytical room

## THE EDEN TEAM



DANIEL SCHUBERT studied at the Technical University of Berlin and has an engineering diploma in industrial engineering with emphasis on aerospace and production techniques. In 2011, he initiated the EDEN group at the DLR Institute of Space Systems for technology investigations on Bio-regenerative Life Support Systems and is since then the team leader of this group. His research expertise is set on habitat interface analysis and plant accommodation and dynamic plant production planning.



Dr. MATTHEW BAMSEY holds a M.Sc. in aerospace engineering (University of Colorado, USA) and conducted his Ph.D. in environmental biology with the University of Guelph (Canada). Matthew worked as a postdoctoral researcher at the University of Florida where he supported suborbital plant growth payload developments. He spent over ten years working as an intern at the Canadian Space Agency where he worked with the Arthur Clarke Mars Greenhouse project. Within EDEN, he conducts research related to nutrient delivery systems.



Chen Dong holds a M.Sc. in genetic breeding (Nanjing Forestry University, China) and is doing his Ph.D. in biological engineering with Beihang University (Beijing, China). During his Ph.D. research, Chen was selected from several candidates to participate in the Chinese Lunar Palace-1 Mission for 105 days in 2014. He lived together with two other crew members in a space simulation bio-regenerative life support system facility in Beijing. Chen is presently working with the EDEN team as a guest scientist under a scholarship from the China Scholarship Council.



CONRAD ZEIDLER is member of the EDEN research team since January 2011. Within his Industrial engineering diploma at the Technical University of Braunschweig he specialized on aerospace engineering and has profound knowledge trade-off analysis techniques (e.g. AHP). He is an expert in simulation methods and control software. Within EDEN, he is responsible for monitoring and controlling the plant growth and environment parameters.



PAUL ZABEL studied aerospace engineering at the Technical University of Dresden. He joined the EDEN team in 2012. Mr. Zabel is the deputy manager of the EDEN Lab and is working on acquiring funding and projects for EDEN. His research expertise is hybrid Life Support Systems containing greenhouse modules and physical/chemical LSS. Funded over NPI (ESA) he is doing his Ph.D. about the dynamic behavior of such hybrid systems.



VINCENT VRAKKING studied at the Technical University of Delft in the Netherlands and holds a M.Sc. in aerospace engineering. He has worked with the EDEN team on and off since 2012, before joining the team in 2015. Within the EDEN group he investigates the potential use of lightweight inflatable materials and structures that can house Bio-regenerative Life Support Systems and greenhouse systems in particular.





# EDEN ISS KICK-OFF

## THE FIRST STEP TOWARDS SPACE

The EDEN ISS kick-off meeting took place at the German Aerospace Center (DLR) Institute for Space Systems in Bremen, Germany on March 5, 2015. Representatives of all 13 project partners and the European Commission attended the meeting. The 43 participants discussed the project plan and celebrated the official start of the project.

After the welcoming speeches by Christos Ampatzis (EU Research Executive Agency), Oliver Romberg (DLR) and Daniel Schubert (DLR), the consortium partners introduced themselves and described their role in the project. Lunch was served in the entry hall of the institute's new laboratory building. The presentations and discussions after the lunch break were focused on the project schedule, work plan and communication. Meeting participants also helped select the final EDEN ISS project logo from several remaining finalists. The kick-off meeting was concluded with a presentation from Paul Zabel (DLR) explaining the next steps of the project.

Bringing together for the first time such a diverse set of researchers meant that the DLR EDEN team spent extra care in organizing the kick-off meeting. This involved a busy period of several weeks organizing general meeting logistics, the event social program as well as technical content related to meetings presentations and other overall EDEN ISS project management concerns.



EDEN ISS kick-off meeting lunch break within the DLR Bremen laboratory building



The EDEN ISS partners attending the project kick-off meeting in March 2015



Coffee break discussions between Giorgio Boscheri (TASI), Giuseppe Bonzano (AS) and Alessandro Petri (AS)



Dinner discussions between Matthew Bamsey, Thomas Graham (NASA/UoG) and Conrad Zeidler



Paul Zabel presenting the road to CDR to the consortium



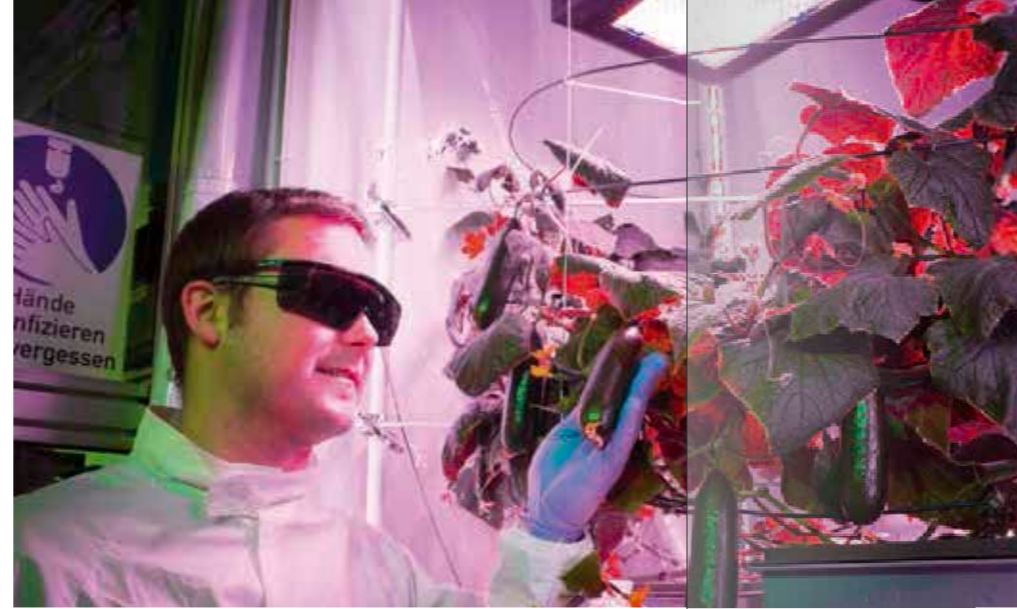
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 636501







Cucumber growth trials within the EDEN Lab



Paul Zabel checking-in on the cucumber spiral growth tests



Dominik von Borell measuring the nutrient solution quality within the ORBITEC plant growth system



EDEN Lab grown lettuce

## LABORATORY AND EXPERIMENTS

### MORE SPACE FOR INTEGRATED TESTING

For the EDEN laboratory, 2015 was the year with the highest yield so far. All growth chambers were in continuous use for the first nine months of the year. The EDEN group continued its test trial with lettuce, but also grew cucumber plants for the first time. The lettuce and cucumber plants developed very well. A test of microbial and plastic contaminants proved, that the harvested plant material was indeed edible. In the last months of 2015 several test chambers were planted with MicroTina, super dwarf tomatoes, which should develop tomatoes in early 2016. In addition to the achievements in plant growth, the EDEN laboratory infrastructure was further improved. Parts of the former external storage area were converted into an additional room.

This room provides additional clean work space and storage capabilities for the team. In November 2015, the preparation of the growth chambers for the upcoming growth trials associated with the EDEN ISS project commenced. The test trials will start early in 2016 with the purpose of growing some of the EDEN ISS crops in the EDEN laboratory.



Lettuce grow-out in the four section EDEN Lab growth chamber



EDEN Lab mini-cucumber



Newly installed EDEN Lab 3D printer



Multilevel growth system within the EDEN Lab incorporating water-cooled OSRAM LEDs and high-pressure aeroponics



Pierre Delmotte, Amin Bin Mohamad Hilmi working in the newly expanded EDEN Lab area



EDEN Lab aeroponically grown lettuce





Week one CE study participants: Matthew Bamsey, Antonio Ceriello, Raimondo Fortezza, Peter Downey, Giorgio Boscheri, Mike Stasiak, Christian Lacopini, Paul Zabel, Frank Kempkes, Daniel Schubert, Vincent Vrakking, Conrad Zeidler, Alberto Battistelli, David Gyimesi, Anthony Gilley, Erik Mazzoleni, Bob Davenport, Eberhard Kohlberg, Giuseppe Bonzano, Amin Bin Mohamad Hilmi

# EDEN ISS CE STUDY

## TWO WEEKS OF DESIGN WORK

In September 2015, the EDEN group conducted the phase A/B Concurrent Engineering (CE) study, in the frame of the EU Horizon-2020 project EDEN ISS. The aim of the study was the generation of a preliminary design for the Mobile Test Facility (MTF) and its subsystems.

The two week study was performed by the EDEN group and involved participants from all project partners. The EDEN group organized the study and was responsible for several subsystem domains. For the first time all partners of the EDEN ISS project worked together at the same location and it demonstrated, once again, the benefits of CE in accelerating the design process.

After two weeks of intensive work, the maturity of the overall design and the subsystem designs had greatly increased. System budgets, requirement documents and CAD models were some of the many outcomes of the study. Located in the parking garage of the institute, a 1:1 mock-up of the MTF was built out of cardboard. It served as a testing subject for handling procedures and was continuously updated throughout the two weeks. The results of the study served as the basis of the further development for each subsystem towards the Critical Design Review (CDR) in March 2016.



Frank Kempes (DLO), Daniel Schubert, and Matthew Bamsey are evaluating the grow accommodation for each plant tray



Visit to the Mobile Test Facility cardboard mock-up in the parking garage



Tom Dueck (DLO) providing the CE study participants a status of crop selection activities



Alberto Battistelli (CNR), Peter Downey (LIT), Bob Davenport (LSG) and Matthew Bamsey participating in a splinter meeting during the CE study



Christian Lacopini (TASI), Giorgio Boscheri (TASI), and Mike Stasiak (UoG), inside the CEF discussing the ISPR-NDS



Antonio Ceriello (TPZ), Paul Zabel, Raimondo Fortezza (TPZ) in thinking mode during the mock-up visit



Daniel Schubert leading a design trade-off discussion during the CE study



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 636501



Panoramic snapshot of the Concurrent Engineering Facility during the EDEN ISS CE study





The Mobile Test Facility installed on its elevated platform as the design looked at the completion of the EDEN ISS CE study



Artistic impression of a view into the Future Exploration Greenhouse



Artistic impression of the Service Section





Chen Dong standing outside the Lunar Palace; Beihang University (China)



A view into the Lunar Palace plant chamber; Beihang University (China)

## CHEN DONG

### A NEW GUEST SCIENTIST SUPPORTS THE EDEN TEAM

In 2014, Chen Dong was selected from several candidates to participate in Chinese Lunar Palace-1 Mission. For 105 days, he lived together with two other crew members in a space simulation bio-regenerative life support system facility in Beijing, China. Lunar Palace missions are conducted by Beihang University and the facility integrates technologies associated with efficient higher plant cultivation, animal protein production, urine nitrogen recycling and solid waste bioconversion. During his Ph.D. research, Chen Dong was responsible for deploying the higher plant cultivation module and conducting plant cultivation experiments within the Lunar Palace habitat.

The EDEN Team is proud to welcome Chen at DLR for his one year exchange. Chen holds a scholarship from the China Scholar Council. He will conduct several growth trials within the closed-loop test facility of the EDEN Laboratory. The EDEN team is looking forward working together and to learn from his closed-loop experiences within the Lunar Palace-1 Mission.



Chen Dong examining wheat within the plant module of the Lunar Palace



Model image of the Lunar Palace







Chairwoman of the AVF Christine Zimmermann-Lössl welcoming the AVF members at the annual AVF meeting in Bremen



## VERTICAL FARMING 2.0

GROWING ANYWHERE, ANYTIME —  
A SOLUTION FOR URBAN AREAS?

On the 17th of November 2015 the Annual Meeting of the Association for Vertical Farming (AVF) took place at the German Aerospace Center (DLR) Bremen. The AVF is an internationally active nonprofit organization focusing on advancing Urban and Vertical Farming technologies, designs and businesses. During the annual meeting about 50 AVF members from various companies and universities around the globe came together to discuss the recent activities of the AVF.

In addition, to hosting the AVF annual meeting, the EDEN team organized a three day CE design study (18th - 20th of November 2015), named Vertical Farm 2.0. The study team consisted of an international team of leading experts in the area of horticulture, systems engineering, indoor farming, and city planning in order to push the knowledge boundaries of Vertical Farming. During the design study an optimal design of a regenerative (semi-automated) Vertical Farm, which could be integrated in an inner city area was conceptualized, including all relevant aspects of advanced plant cultivation. A large focus was placed on the implementation of Controlled Environment Agriculture (CEA) technologies, labour, production techniques, energy efficiency, and yield maximization. Not only was the technical feasibility investigated, but also the economical (cost analysis) aspects of such a system. The study report will be used to initiate an important discussion regarding the deployment of Vertical Farming and its economic- and environmental impacts on society. With this study the EDEN initiative strives to transfer knowledge, gained from their research domains, into terrestrial applications.



Oscar Rodriguez (Architecture and Food) and Oscar Rodriguez Henry Gordon-Smith (AVF) discussing the layout of the internal equipment

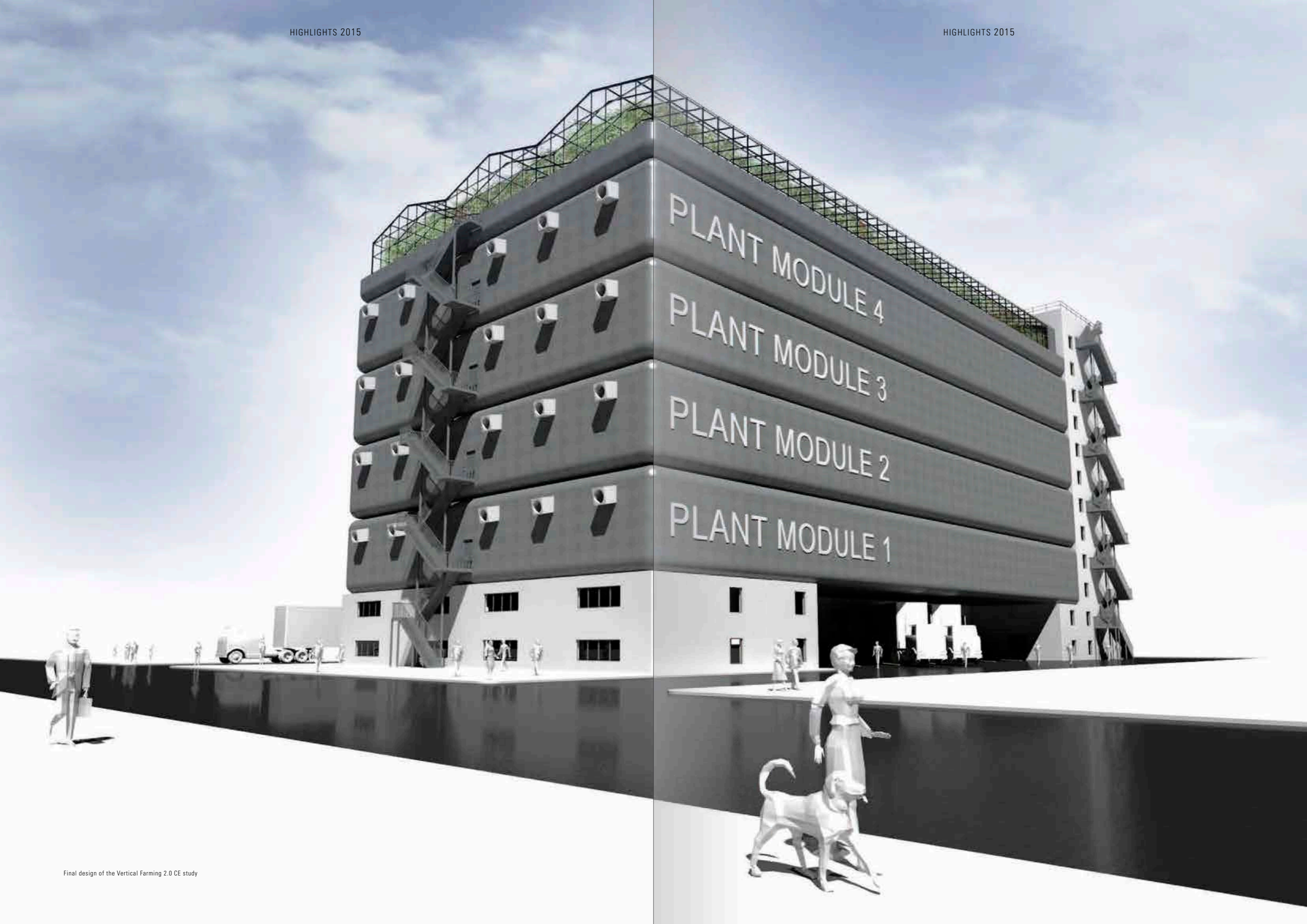


Splinter meeting about plant parameters for the Vertical Farm 2.0



Group photo of all AVF members at the annual AVF meeting in Bremen









Daniel Schubert presents artificial grown lettuce head to a school class

## EDEN FOR KIDS

### LEARNING ABOUT PLANTS IN SPACE

2015 was also an important year of student engagement and outreach. Embedded in the teaching strategy of DLR's School\_Lab, the EDEN team elaborated together with students and teachers the 'EDEN for Kids' learning- and outreach program.

The goal of this program is to facilitate the awareness of bio-regenerative closed-loop technologies in space. What environmental factors do the plants need within an extraterrestrial greenhouse on the Moon or Mars? Do plants better grow in Lunar or Martian regolith? What is the best light spectrum for plant growth? These and other similar questions is the main topic of the 'EDEN for Kids' program.

Together with the School\_Lab, the EDEN Team built six low-cost grow chambers with adjustable LED lights and a small air management system for temperature and humidity regulation. With these simple grow chambers the pupils could conduct several growth trails with watercress during a six week school campaign. A special grow handbook for the students and an accompanying teacher's handbook with useful background information promoted this program even further.

During the first school campaign, two school classes (30 students each) were invited to the kick-off meeting at DLR, including a visit of the EDEN Laboratory and a Q&A session with the EDEN scientists. This learning program will be continued and steadily improved within the coming years in order to improve the awareness space exploration and sustainability on Earth.



Test run of one growth box for the EDEN for Kids outreach program



Daniel Schubert explaining the factors for optimal plant growth within closed-loop environments



A visit in the EDEN Laboratory at the beginning of the School\_Lab project 'Eden for Kids'



The EDEN- and the Schol\_Lab Team built 10 low-cost plant growth boxes. The boxes can control light spectrum, relative humidity and temperature



Closed up of the grow experiments, conducted during the School\_Lab outreach and education campaign



# KEY FIGURES - 2015

## PEER-REVIEWED CONFERENCE PROCEEDINGS

P. Zabel, M. Bamsey, C. Zeidler, V. Vrakking, B.-W. Johannes, [...]. "Introducing EDEN ISS - A European project on advancing plant cultivation technologies and operations", 45th International Conference on Environmental Systems, ICES-2015-198

Bamsey, M.T., Zabel, P., Zeidler, C., Gyimesi, D., Schubert, D., Kohlberg, E., Mengedoht, D., Rae, J., Graham, T. (2015) *Review of Antarctic greenhouses and plant production facilities: A historical account of food plants on the ice*, 45th International Conference on Environmental Systems, ICES-2015-060

## CONFERENCE PROCEEDINGS

E. Mazzoleni, D. Schubert, "Air Management Engineering for a Greenhouse Module For Space System", Session Bioregenerative Technologies, Subsystems, Components and Materials; ISLSWG; Turin, 18. - 19.05. 2015

## INVITED TALKS

Zeidler, Conrad, et al. (2015) *Neue Technologien für die Produktion von Nahrungsmitteln in urbanen Ballungsgebieten*. Forum Life Science, 12.03.2015, München, Deutschland

D. Schubert: "The EDEN Initiative of DLR", *Jugend forscht!*, Universität Bremen, 17.02.2015

## POSTERS

Markus Dorn: "Analyse von Säulenapfelbäumen für den Einsatz in extraterrestrischen Habitaten (EVA-System)"; Poster, University of Natural Resources and Life Sciences, Vienna, 2015, Department of Crop Sciences, 2015

## DIPLOM-/ MSC.-/ BSC.-THESIS

Streblov-Linder, S., "Pflanzen auf dem Mars - Entwicklung und Evaluation eines Unterrichtsmodells in Kooperation mit dem deutschen Zentrum für Luft- und Raumfahrt", 2015

## REPORTS (INTERNAL/EXTERNAL)

Zabel, P., "TN 3.1 - Definition of generic ECLSS functions", SCALISS - Scaling of Life Support Systems, ESA, 2015

Zabel, P., "TN 3.2 - Definition of ECLSS functional architectures", SCALISS - Scaling of Life Support Systems, ESA, 2015

Bamsey, M., "D1.2 - Data Management Plan", EDEN ISS, 2015

Rößler, J., Hobbie, C., Schubert, D., "D1.1 - Quality Management Plan", EDEN ISS, 2015

Hogle, M., Zabel, P., Bamsey, M., Schubert, D., "D7.10 - Dissemination Plan", EDEN ISS, 2015

Zeidler, C., Zabel, P., Schubert, D., Bamsey, M., Vrakking, V., Gyimesi, D., Rettberg, P., Barczyk, S., Davenport, B., Wacławicek, R., Battistelli, A., Nazzaro, F., Stasiak, M., Kohlberg, E., Mengedoht, D., Mazzoleni, E., Magnabosco, D., Fetter, V., Boscheri, G., Guarnieri, E., Locantore, I., Bonzano, G., Kempkes, F., Dueck, T., Stanghellini, C., Gilley, A., Bennett, M., Downey, P., Larkin, T., Ceriello, A., Fortezza, R., "D2.5 - Design Report", EDEN ISS, 2015

Bamsey, M., *EDEN ISS Sample Storage and Return Requirements*, EDEN ISS, 2015

Bamsey, M., *Neumayer Station III - Exterior Environmental Conditions Summary*, EDEN ISS, 2015

Anneke Höhn: "Growing Butterhead Lettuce in a Closed Aeroponic System: Link between Ecology and Sustainability", Research project, University Bremen, Germany

## SPECIAL

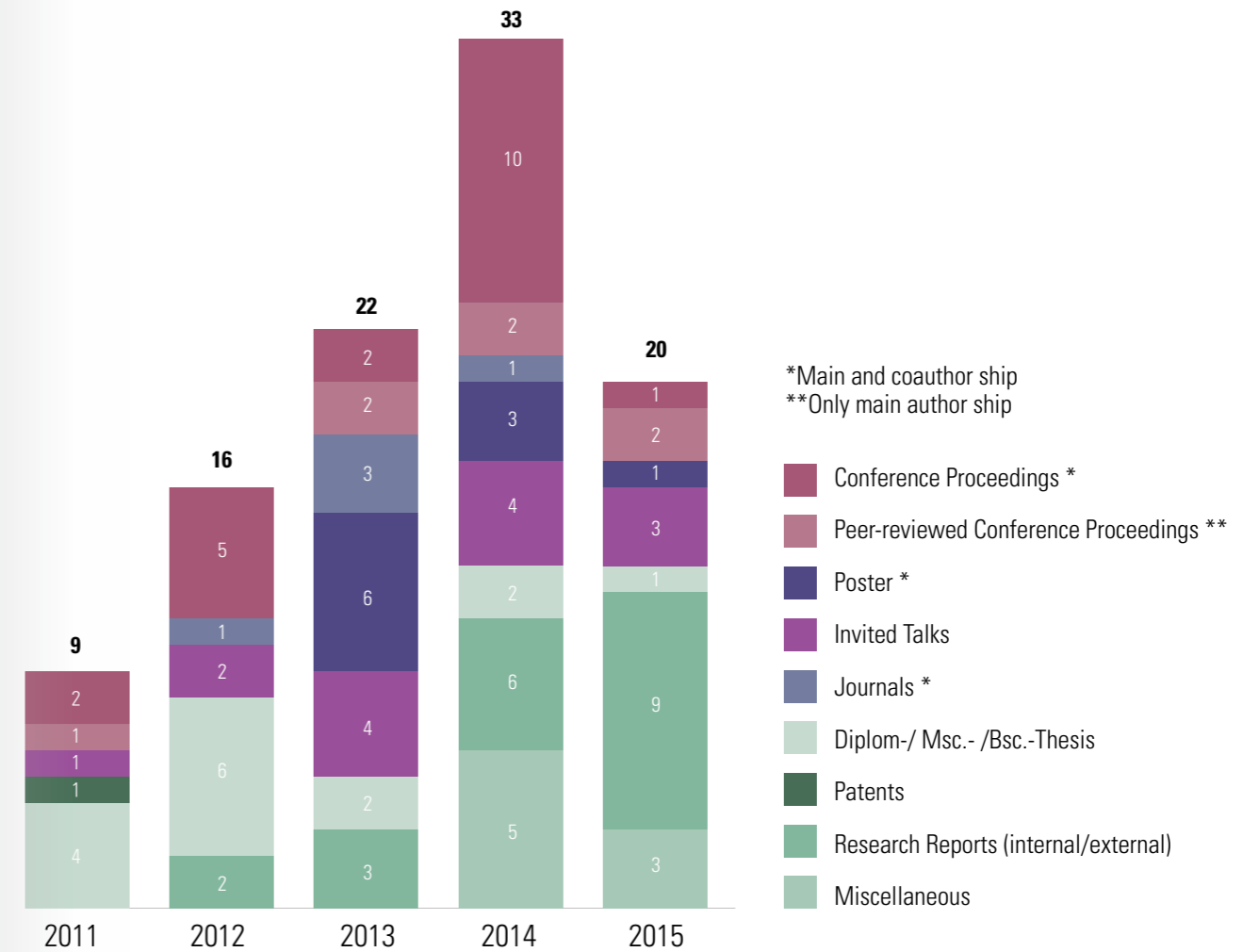
Chambliss, J. (2015) *Life Sciences and Systems 2015 Year in Review*. AIAA Aerospace America, December 2015

Member of the Delphi-Group of the German Bioeconomy Council; *Bioeconomy Council is an independent advisory body to the German Federal Government*; 2015, Berlin

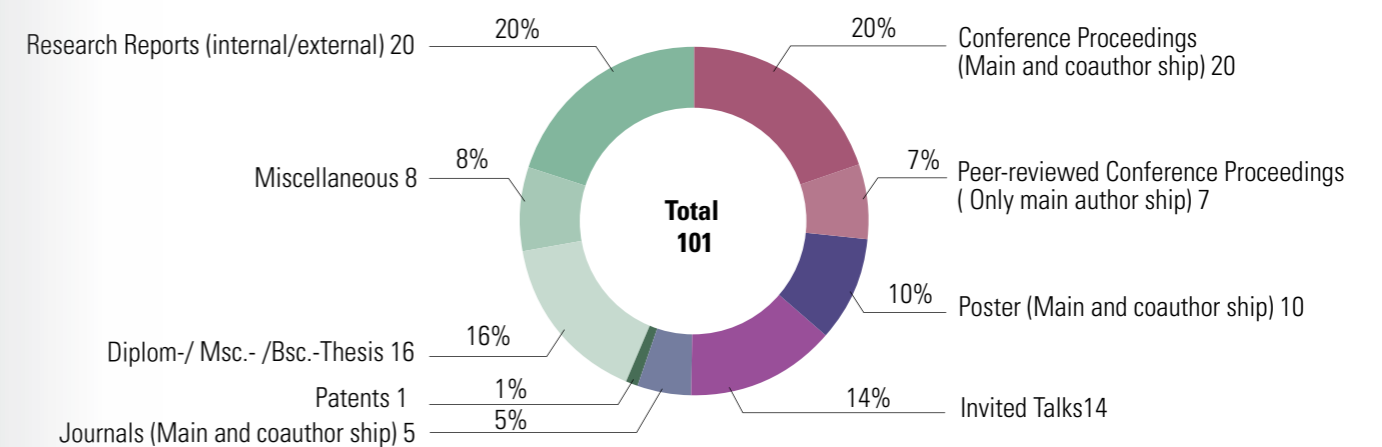
Schubert, D., "Künstliche Natur", *forscher - Das Magazin für Neugierige*, Vol. 2, 2015

# SUMMARY KEY FIGURES (2011-2015)

## PUBLICATIONS & KEY FIGURES 2011-2015



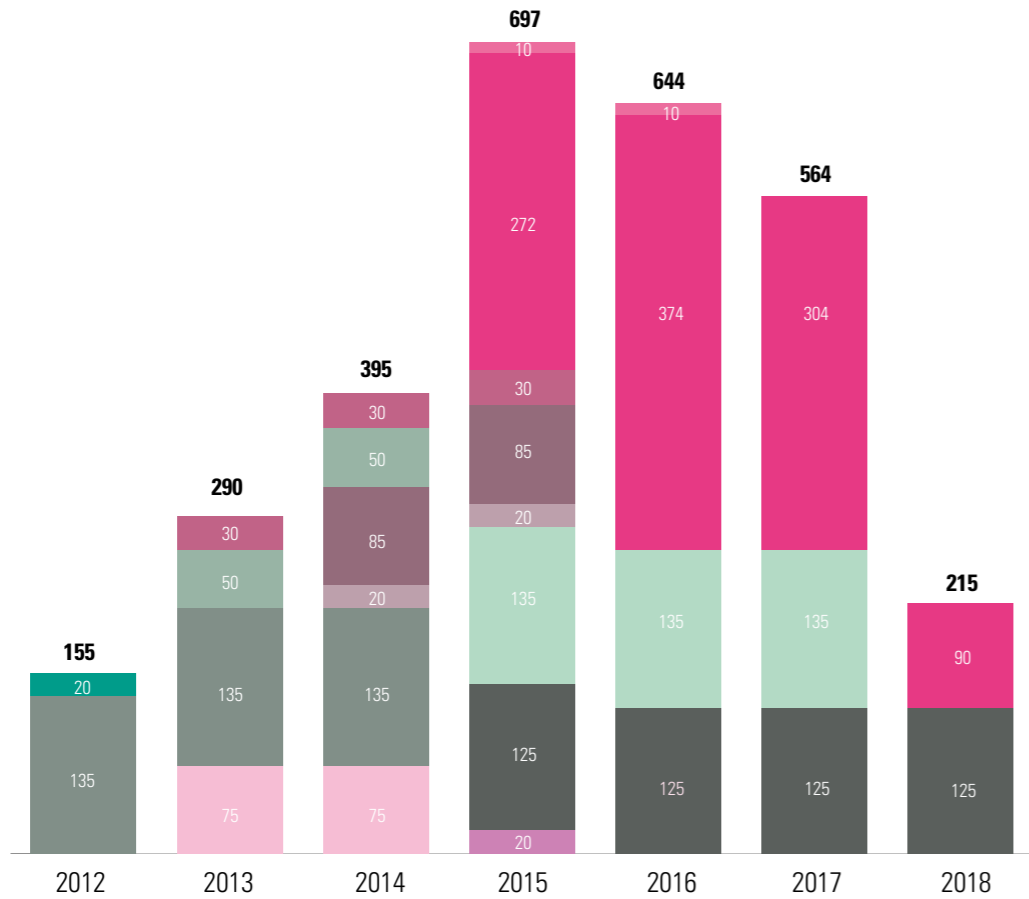
## TOTAL PUBLICATIONS & KEY FIGURES 2011-2015





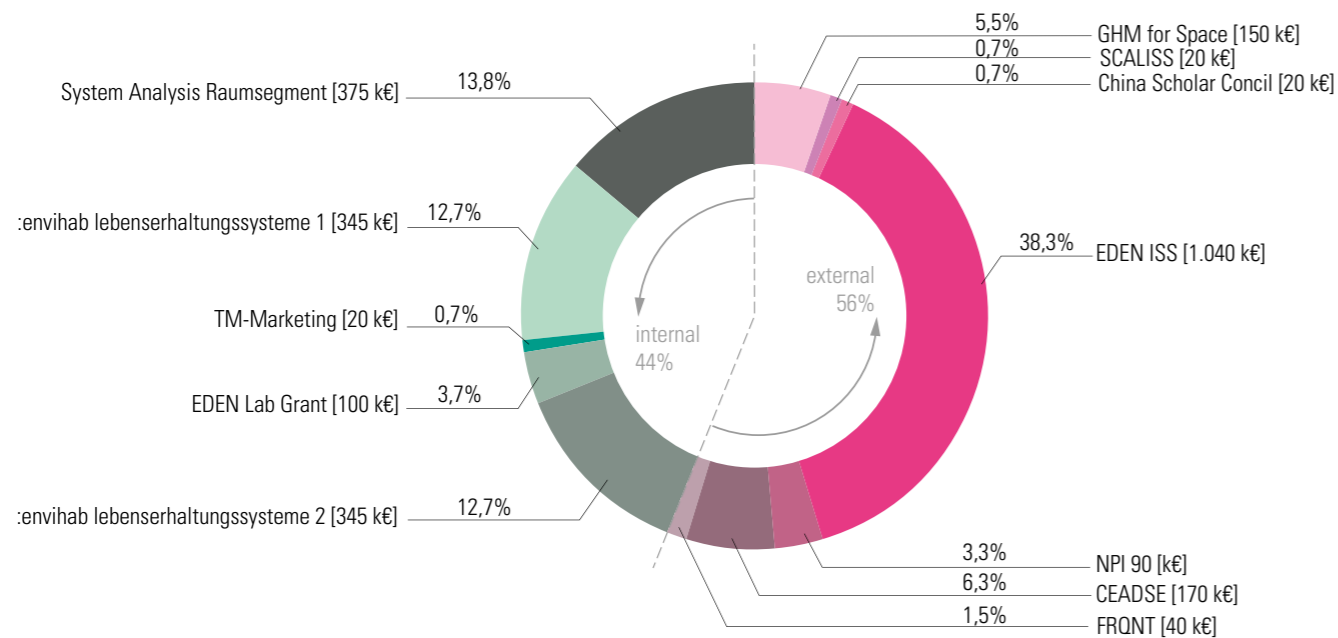
BUDGETS OVERVIEW & FORECAST 2012-2018

[k€]



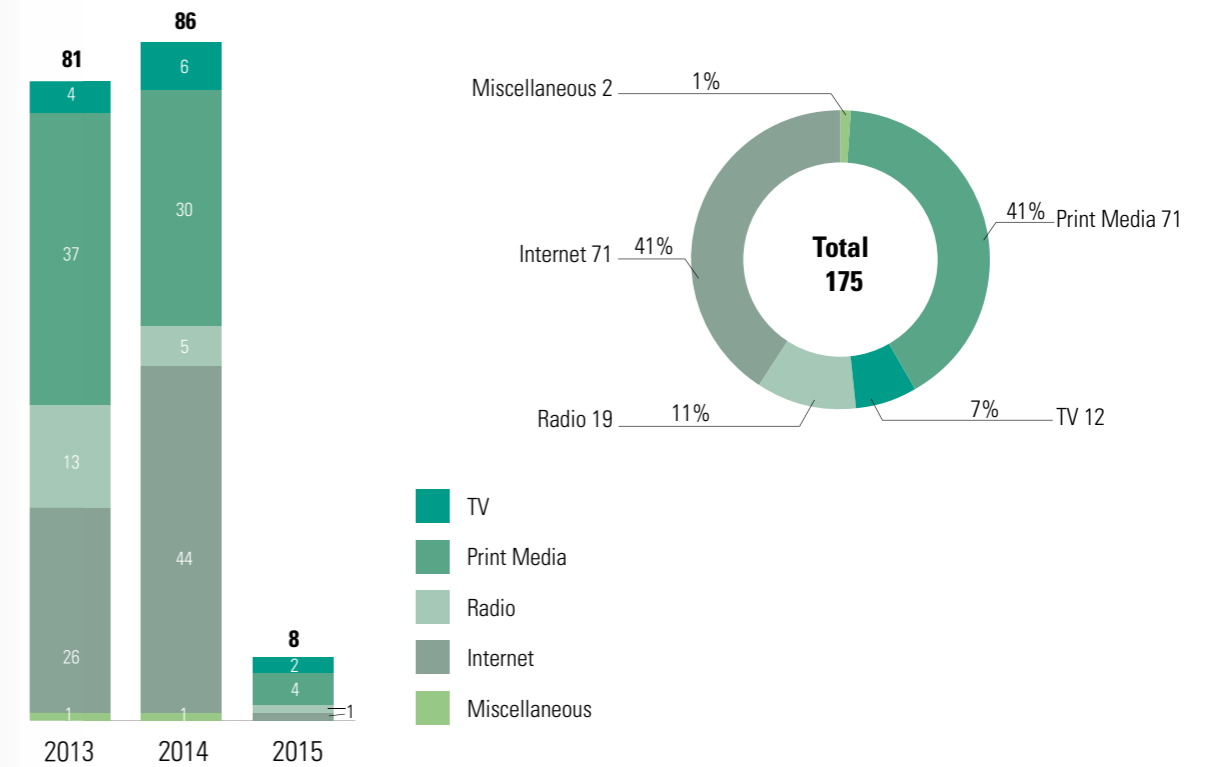
- China Scholarship Council
- Systemanalyse Raumsegment
- NPI
- :envihab lebenserhaltungssysteme 2
- :envihab lebenserhaltungssysteme 1
- EDEN ISS (H2020)
- CEADSE
- SCALISS
- EDEN Lab Grant
- GHM for Space
- TM-Marketing
- FRONT

TOTAL BUDGETS DISTRIBUTION 2012-2018 [in k€]

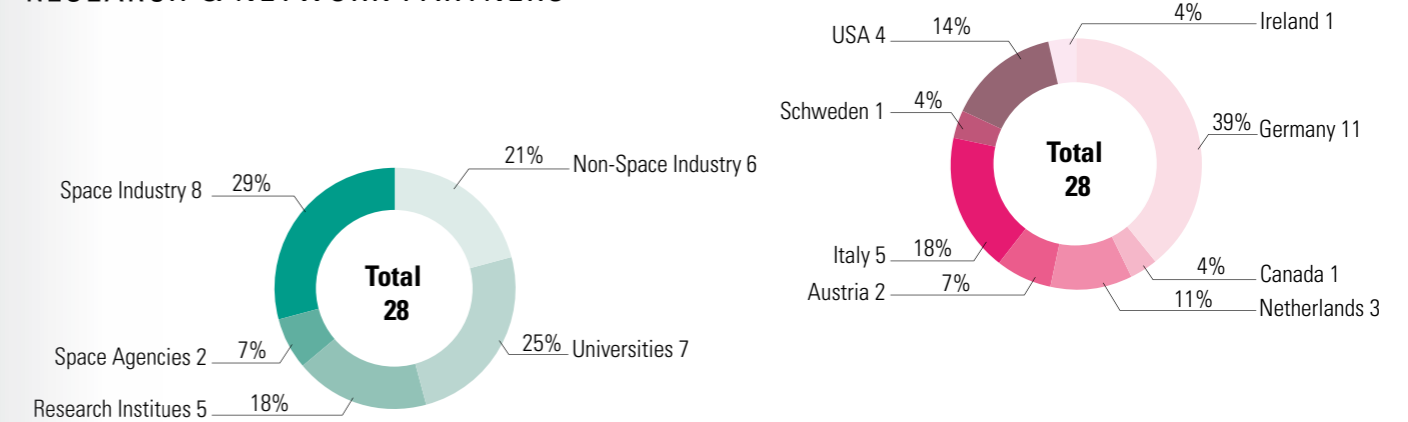


Note: Pink represent third-party money (total 56%); Green pies represent DLR internal budgets (total 44%); Budgets of proposals are not included in this chart.

MEDIA ACTIVITIES 2013-2015 (TOTAL AND YEARLY DISTRIBUTION)

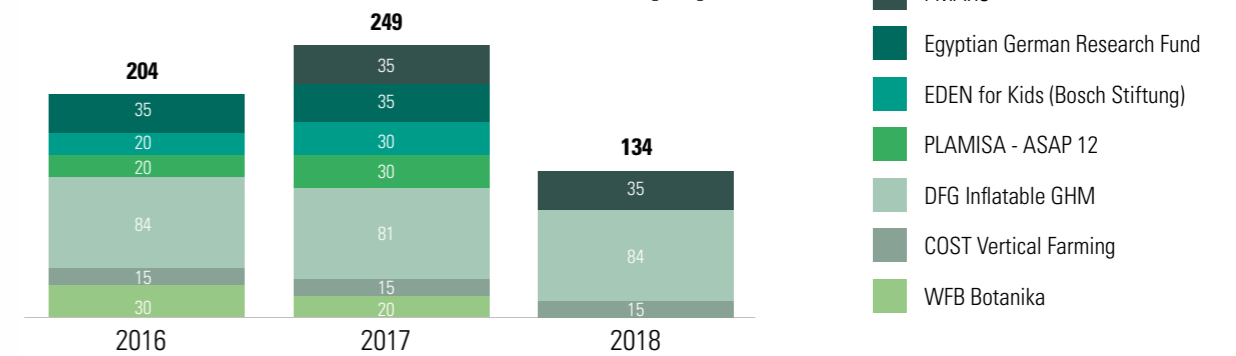


RESEARCH & NETWORK PARTNERS



PENDING PROPOSALS

[k€]





## THE EDEN STUDENTS

Without the assistance and help of highly-motivated students, the success of the EDEN Initiative would not have been possible! Therefore the entire EDEN team would like to say thank you. See below what the student's tasks were and what they are doing now:



Hannah Effertz is an ecologist, who is currently studying her Bachelor of Education in biology and chemistry and is working as a student assistant in the DLR\_School\_Lab since April 2015. Besides the supervision of students in the DLR\_School\_Lab she coordinates the project "EDEN for kids", which is a cooperation between the EDEN initiative, the DLR\_School\_Lab and the didactics of Biology from the University of Bremen. In this long-term project school classes can perform plant-growth experiments in special grow chambers in the school, get in touch with scientists and learn about space missions and plant growth on Mars.



Alexander Bell is an undergraduate student at the University of Bath studying for a Master's degree in Electrical & Electronic Engineering. During his internship within the EDEN Initiative he has programmed a PLC (Programmable Logic Controller) responsible for controlling four growth chambers. In addition to this he worked on a variety of projects in the lab including growing lettuce. Alex has now returned to the University of Bath for a further two years in order to complete his Master's degree.



David Gyimesi is an aerospace engineer undergraduate student from the University of Surrey. During his fifteen months internship at EDEN he helped with the upkeep of the EDEN Laboratory, participated in two concurrent engineering studies and conducted plant growth experiments. He also carried out a literature review related to micro gravity plant growth experiments and life support systems. He is currently back in the UK to continue his studies.



Anneke Höhn is a student assistant of the DLR\_School\_Lab and additionally took over small tasks in the EDEN\_Lab. She is enrolled in the Master of Ecology at the University of Bremen and therefore has conducted a 3-month Research Project in the EDEN\_Lab at the beginning of 2015. Major parts of the project were dealing with impacts of light intensities on lettuce growth in an aeroponic system and the variation of light quantity and quality within one plant-growth tent. Anneke coordinated the "EDEN for kids" project, which is a cooperation between the EDEN initiative, the DLR\_School\_Lab and the didactics of Biology from the University of Bremen. In this long-term project school classes can perform plant-growth experiments directly at the school in special plant-boxes, get in touch with scientists and learn about space missions and plant growth on Mars.

## IMPRESSIONS 2015

THE YEAR EDEN GOT GOING...



BBO for the EDEN ISS design team at the end of the first week of the CE study in Sep. 2015



Frank Kempes (DLO) and Bob Davenport (LSG) discussing plant values during the CE study



Eberhard Kohlberg (AWI) at the CE session



Alberto Battistelli (CNR) and Peter Downey (LIT) both responsible for the domain Food Quality & Safety for the EDEN ISS project

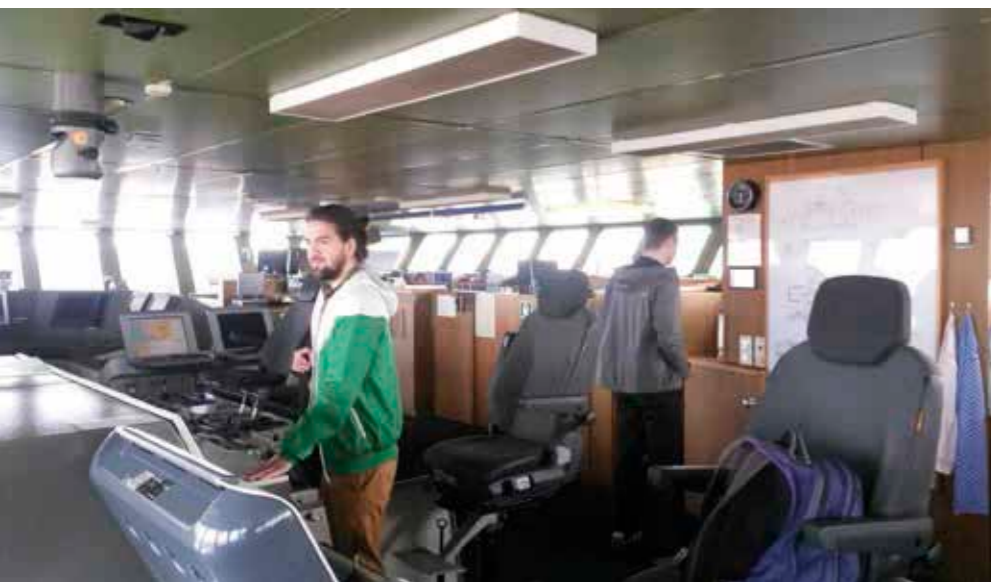


Viktor Fetter (ADS) inside the 1:1 mock-up of the Mobile Test Facility (MTF) built in the DLR parking garage during the EDEN ISS design study



Erik Mazzoleni (ES) and Giuseppe Bonzano (AS) during a domain session inside the CEF





Onboard the bridge of the Polarstern, the German vessel that will transport the EDEN ISS greenhouse container to Antarctica



Matthew Bamsey onboard the vessel Polarstern



Daniel Schubert sorting out different options during an internal EDEN strategy meeting



Initial design and layout consideration of the Antarctic greenhouse system. Paul Zabel and Conrad Zeidler are marking the internal layout on the floor of the DLR conference room



Visit of the Polarstern vessel of AWI in order to discuss the transport of the greenhouse container to Antarctica





Over 2000 booklets of the magazine „Künstliche Natur“, forscher - Das Magazin für Neugierige of the BMBF were delivered to the EDEN team. A small article about the team was written in it.



Lettuce harvest inside the EDEN laboratory



Butterhead lettuce ready for consumption



Anneke Höhn, Pierre Delmotte, Chen Dong, and Armin Bin Mohamad Hilmi during overall clean-up of the clean room inside the EDEN lab



Always some room for fun during the lab visit of a school class



Paul Zabel inside the EDEN Laboratory, thermally insulating the air management cooling coil



Bottle Crop experiments with lettuce



Team building event; The EDEN group is having a BBQ @ Daniel's apartment in August 2015

Pierre Delmotte, Chen Dong, and Bin Mohamad Hilmi cleaning the growth chambers



Matthew Bamsey, Vincent Vrakking, and Paul Zabel in the EDEN Lab





Theresa Rondeau Vuk (UoG) and Ines Sander (DLR) at the EDEN ISS kick-off dinner



Anthony Gilley (HS), Tom Dueck (DLO), and Grazyna Bochenek (HS) at the EDEN ISS kick-off meeting in March 2015



Social event during the EDEN ISS kick-off meeting; Downtown Bremen at the Katzen-Cafe restaurant



Raimondo Fortezza (TPZ) at the social dinner



Chris Gilbert (LSG), Mike Dixon (UoG), and Enrico Gaia (TASI) during the social dinner



Bernd Johannes (DLR-ME), Oliver Romberg (DLR-RY), and Dirk Mengedoht (AWI) discussing the EDEN ISS mission during coffee break



Design team of the Vertical Farm 2.0 study, held in November 2015 at the CEF in Bremen



Andrew Carter (Blue Planet Environmental) and Martin Veenstra (Certhon) discussing during offline session of the Vertical Farming 2.0 CE-study



Dinner during the annual meeting of the Association for Vertical Farming (AVF), held at the DLR Institute in Bremen in November 2015



Daniel Schubert at a meeting with the Umwelt Bundesamt (UBA), presenting the Antarctic greenhouse system to authorities of the German Government



Jasper den Besten (HAS University of Applied Sciences) and Anthony Gilley (HS) discussing the lighting plan for the Vertical Farm 2.0

Some fun at the group picture shooting during December 2015







Left to right: Chen Dong, Dr. Matthew Bamsey, Mareike Maurer, Tobias Wagner, Bin Mohamad Hilmi, Hannah Effertz, Vincent Vrakking, Conrad Zeidler, Paul Zabel and Daniel Schubert

Issue 2  
Bremen, June 20th, 2016

German Aerospace Center  
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## DLR at a Glance

DLR is the national aeronautics and space research centre of the Federal Republic of Germany. Its extensive research and development work in aeronautics, space, energy, transport and security is integrated into national and international cooperative ventures. In addition to its own research, as Germany's space agency, DLR has been given responsibility by the federal government for the planning and implementation of the German space programme. DLR is also the umbrella organisation for the nation's largest project management agency.

DLR has approximately 8000 employees at 16 locations in Germany: Cologne (headquarters), Augsburg, Berlin, Bonn, Braunschweig, Bremen, Goettingen, Hamburg, Juelich, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Stade, Stuttgart, Trauen, and Weilheim. DLR also has offices in Brussels, Paris, Tokyo and Washington D.C.

DLR's mission comprises the exploration of Earth and the Solar System and research for protecting the environment. This includes the development of environment-friendly technologies for energy supply and future mobility, as well as for communications and security. DLR's research portfolio ranges from fundamental research to the development of products for tomorrow. In this way,

DLR contributes the scientific and technical expertise that it has acquired to the enhancement of Germany as a location for industry and technology. DLR operates major research facilities for its own projects and as a service for clients and partners. It also fosters the development of the next generation of researchers, provides expert advisory services to government and is a driving force in the regions where its facilities are located.



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