Oïkosmos research agenda: relevance of manned interplanetary missions to terrestrial sustainability

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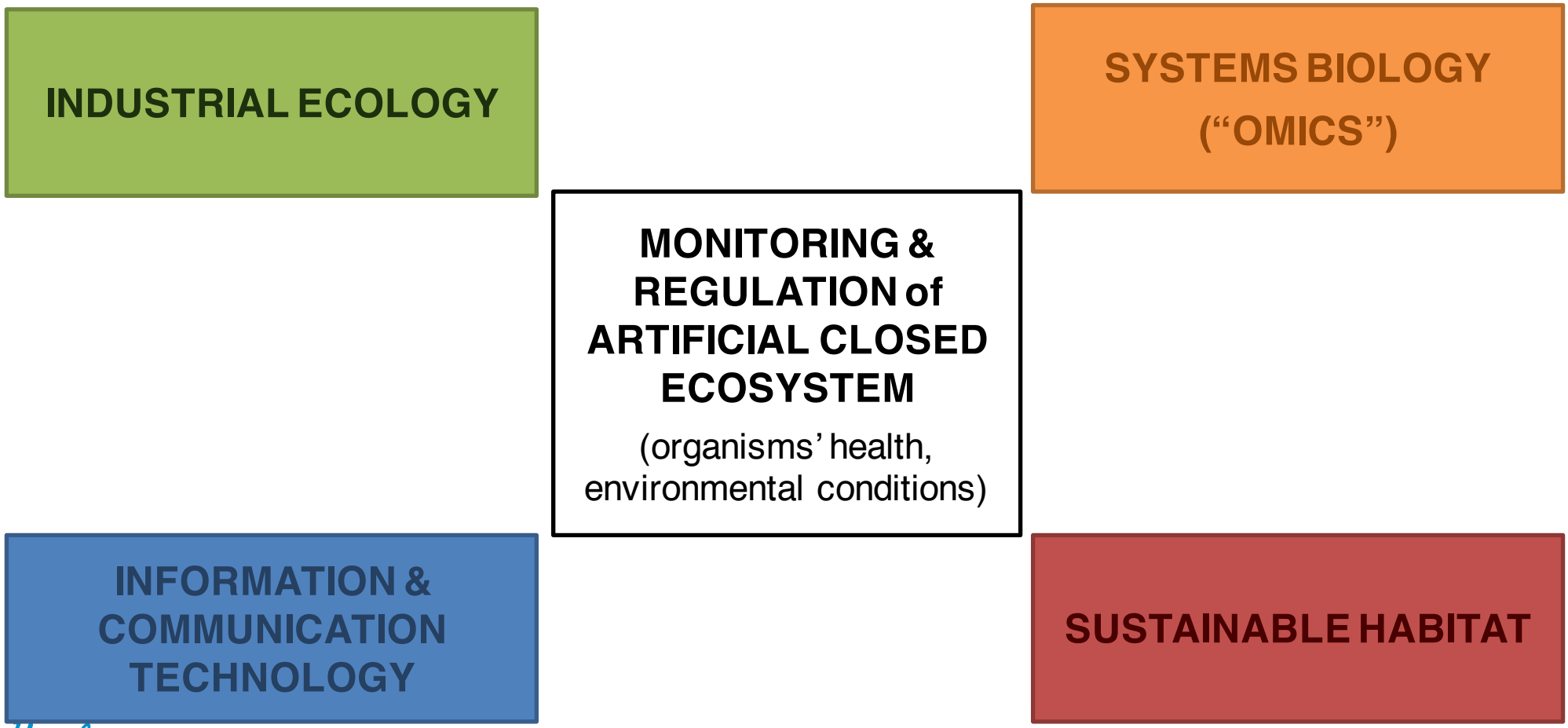
Institut des dynamiques de la surface terrestre

UNIL is working on the relevance of MELiSSA for terrestrial sustainability

UNIL has elaborated a preliminary terrestrial research agenda on artificial closed ecosystem (= Oïkosmos programme)



Facility for Integrated Planetary Exploration Simulation (FIPES)

➡ the <u>future</u> closed habitat simulator with MELiSSA as BLSS

A human demonstrator aiming at preparing the mission in the most realistic conditions

“Oïkosmos project” at UNIL

What research programme would maximise space and terrestrial research synergies inside FIPES?

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MELISSA

“Oïkosmos”: terrestrial research fields

INDUSTRIAL ECOLOGY

- Fine regulation of ecosystemic conditions
- Cleantech / Material loop closure / Highly efficient recycling systems
- Ecotoxicolgy
- CO_2 valorisation / Biorefinery

INFORMATION & COMMUNICATION TECHNOLOGY

- Computational sciences / Bioinformatics / Mobile and ubiquitous computing
- Human-machine interactions
- Embedded technologies /smart monitoring
- Telehealth / Telemedecine

MONITORING & REGULATION of ARTIFICIAL CLOSED ECOSYSTEM

(organisms’ health, environmental conditions)

SYSTEMS BIOLOGY (“OMICS”)

- Health biomonitoring
- Monitoring of biomolecules systems (genomic, proteomic, metabolomic)
- Functionnal food / Nutrigenomic
- Microbiomic (microbial flora)

SUSTAINABLE HABITAT

- Ecohabitat / Ecomaterials / Advanced materials
- Healthy living habitat / Habitability / Ergonomy
- Self-sufficient habitat
- Autonomous habitat
- Smart building

Earth-based applications of MELiSSA

Terrestrial applications are geared to operate in circumstances with significant constraints and/or in extreme conditions:

- in **built-up ecosystems** (city infrastructures, residential and industrial areas, hospitals, places hosting large events, hotels and resorts, etc.)
- in **ecosystems suffering from resources shortage** (water, phosphorus, etc.) and/or **pollution** (contaminated resources)
- in **remote regions**, as well as in **confined and isolated habitats** (islands, mountains ecosystems, (Ant)arctic, large ships, bunkers, etc.)

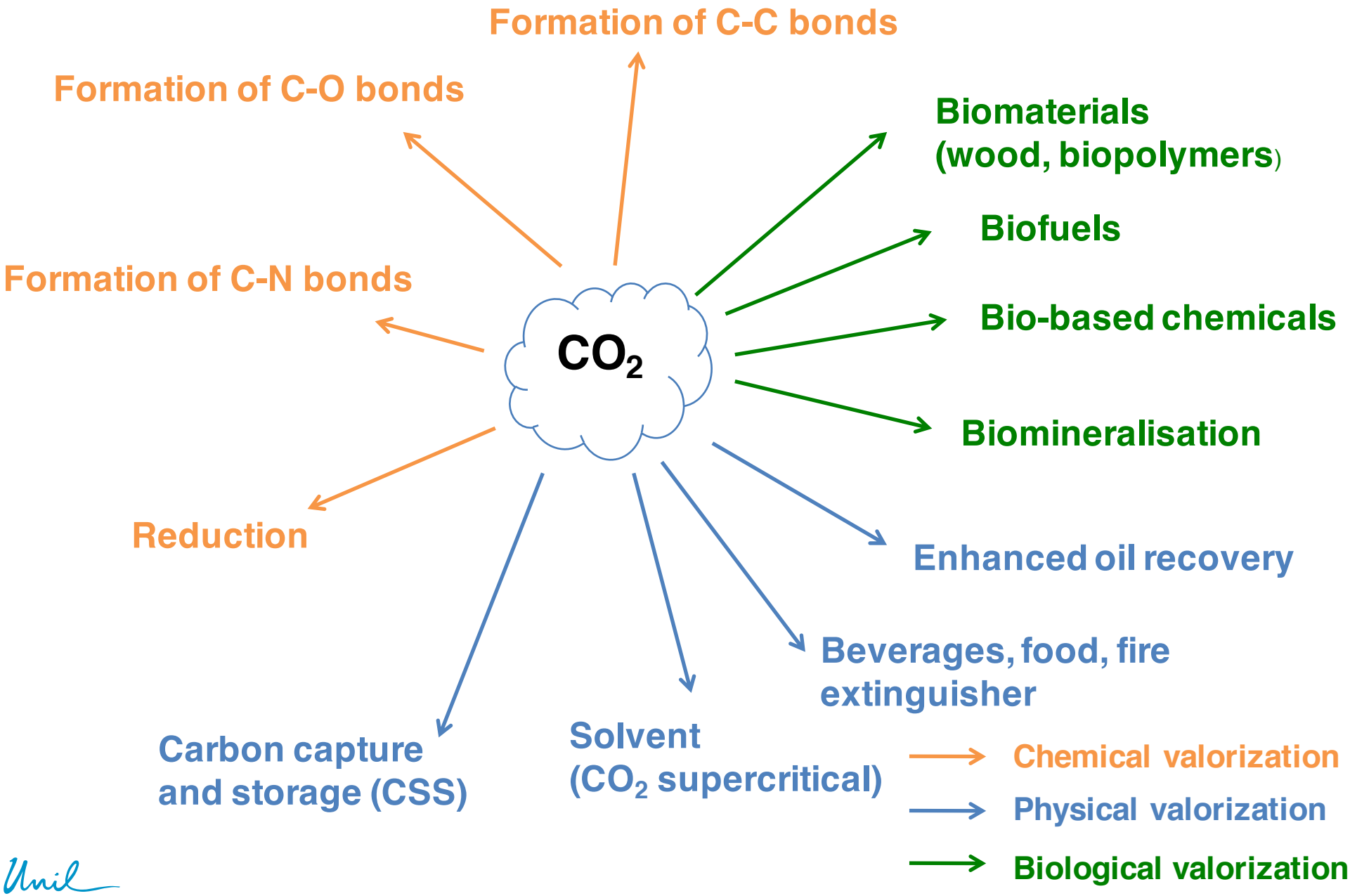
Some industrial ecology-related topics

- **Decentralized wastewater** (yellow and grey water) **treatment** (residential and industrial areas, big events, natural disasters, etc.)
- **Urban farming** (vertical farming, 3D ag, next generation of plant growth systems)
- **Biomass valorization** (industrial synergy/biorefinery, CO_2 valorization)

Industrial ecology: another perspective on CO_2

- "Artificial mine" of carbon (gaseous) in the atmosphere
- Idea: "To mine the atmosphere" and valorize the carbon
- Creation of an "anthropogenic cycle of carbon"

“Global Carbon Wealth”: valorization of CO_2



“Global Carbon Wealth” project

- CO_2 emissions could become a valuable resource
- Challenge of energy cost… but can be addressed
- Implement an “anthropogenic carbon cycle”
- Explore systematically and systemically the various aspects of carbon capture and valorization (legal, political, etc.)

“Global Carbon Wealth”: relevance for Mars

- Going beyond the traditional Sabatier reaction for fuel production (methane)
- Many other opportunities for in-situ resource utilization on Mars, especially for extending the planetary base in the long run (incl. space greenhouses)
- Synthesis of many intermediate chemical compounds to further produce useful biomolecules (such as biomaterials, solvents, plastics, glue, paintings) through “martian biorefinery”

“Oïkosmos project” at UNIL (Part II)

FIPES = Facility for Integrated Planetary Exploration

What are the possible use of FIPES by terrestrial research communities?

FIPES: a state-of-the-art technological platform

- **From research synergies to the technological transfer of useful terrestrial applications**

- **Open to a wide stakeholders ecosystem**
  - ➠ all along the « Research-Innovation-Market » value chain

- **Flexible and dynamic installation**
  - ➠ lab equipments & facility sharing

- **Forum Oïkosmos**
  - ➠ science-society interface
  - ➠ science-industry platform

FIPES: a state-of-the-art technological platform

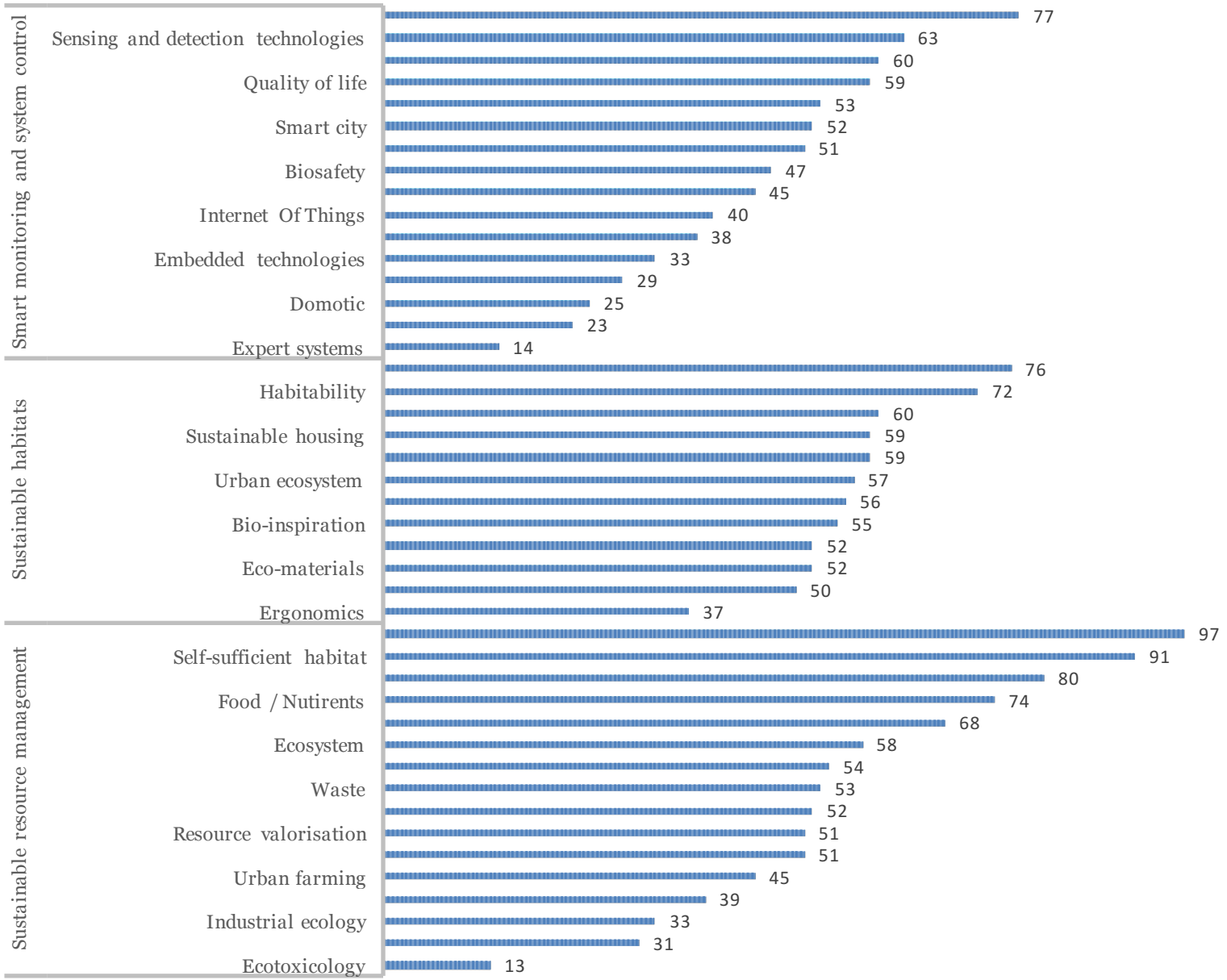
- **Competences center**
  - ➠ “one-stop-shop” for innovative companies & industries
- **Eco-innovation incubator**
  - ➠ spin-off and start-ups creation & support
- **Technological showcase**
  - ➠ devices and installations “made in Europe”

Towards a closed habitat
Intermediary steps before FIPES

Does it make sense to terrestrial industrials and private companies to establish synergies (joint R&D, topical teams, tech platform) on closed habitats together with space community?

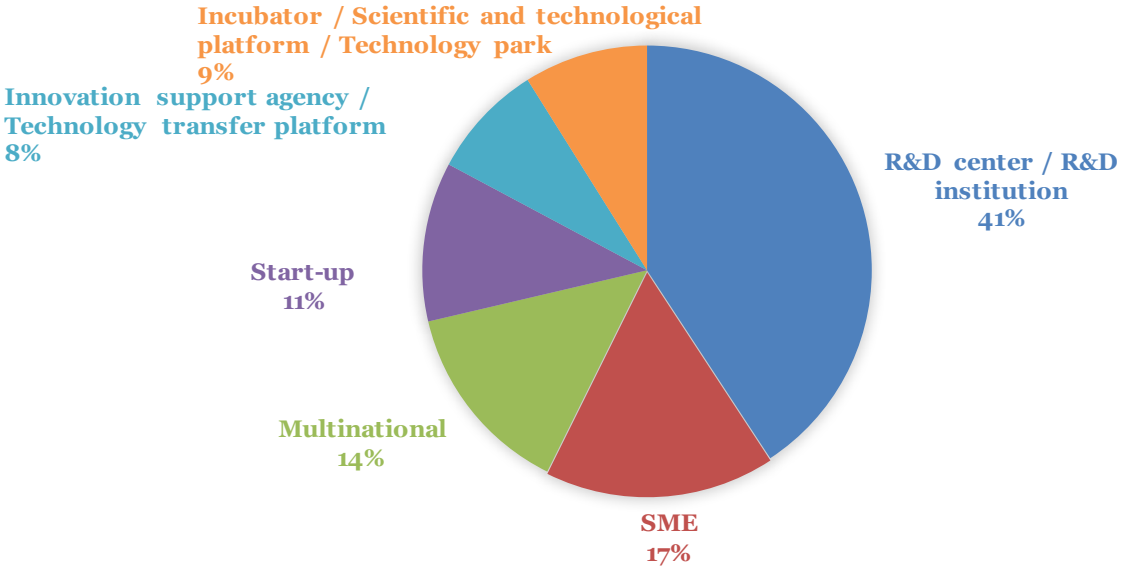
Well, with 130+ registered participants the answer seems to be:
“Yes, definitely!”

FIELD OF INTERESTS OF ESA CLOSED HABITATS FORUM PARTICIPANTS

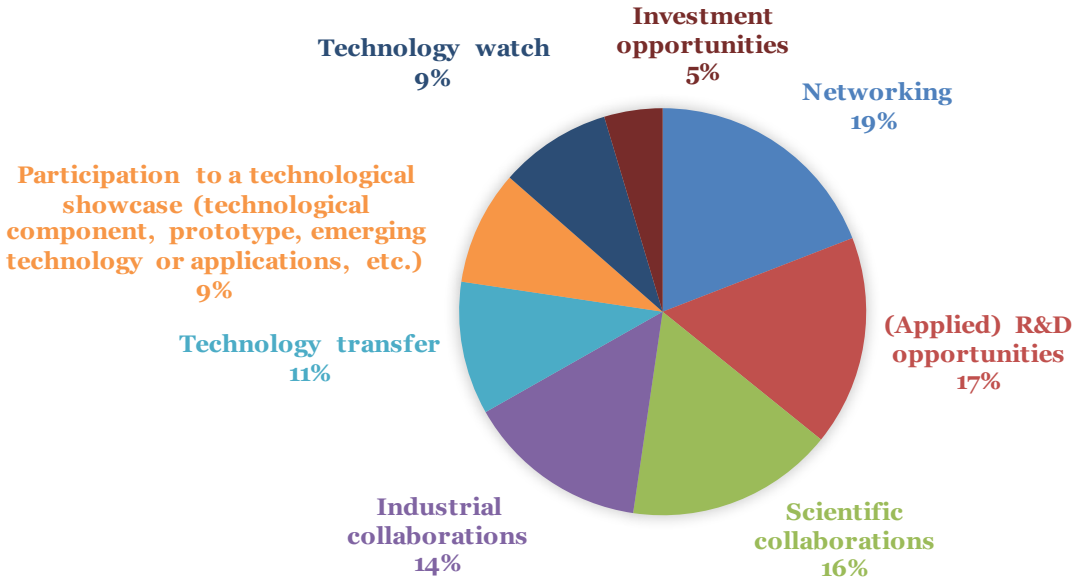


“Yes, this makes sense!

A BROAD DIVERSITY OF ORGANISATION KINDS



PARTICIPANTS EXPECTATIONS ARE NUMEROUS



"Yes, this makes sense!

« Take home message »

- Manned space missions & artificial closed ecosystems: strong potential for R&D and applications to sustainability issues
- Both Mars mission simulator (space analogue) and terrestrial closed habitat could be considered as:
  - a driver for eco-innovation that fosters the technology transfer of useful societal applications
  - a relevant technological platform to model and develop highly efficient recycling systems
- It really makes that space organisations continue to:
  - further integrate environmental thinking within space activities
  - facilitate synergies between terrestrial (confined environment, etc.) and space (esp. life support) R&D

« Take home message »

INTEGRAL RECYCLING

EFFICIENT FOOD PRODUCTION

MANNED INTERPLANETARY MISSIONS & TERRESTRIAL SUSTAINABILITY

BETTER COMMUNICATION

BETTER LIFE

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Thank you very much!

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