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# Inter- and trans-disciplinarity risks in energy system transformation research

June 21st, Fabian Schipfer

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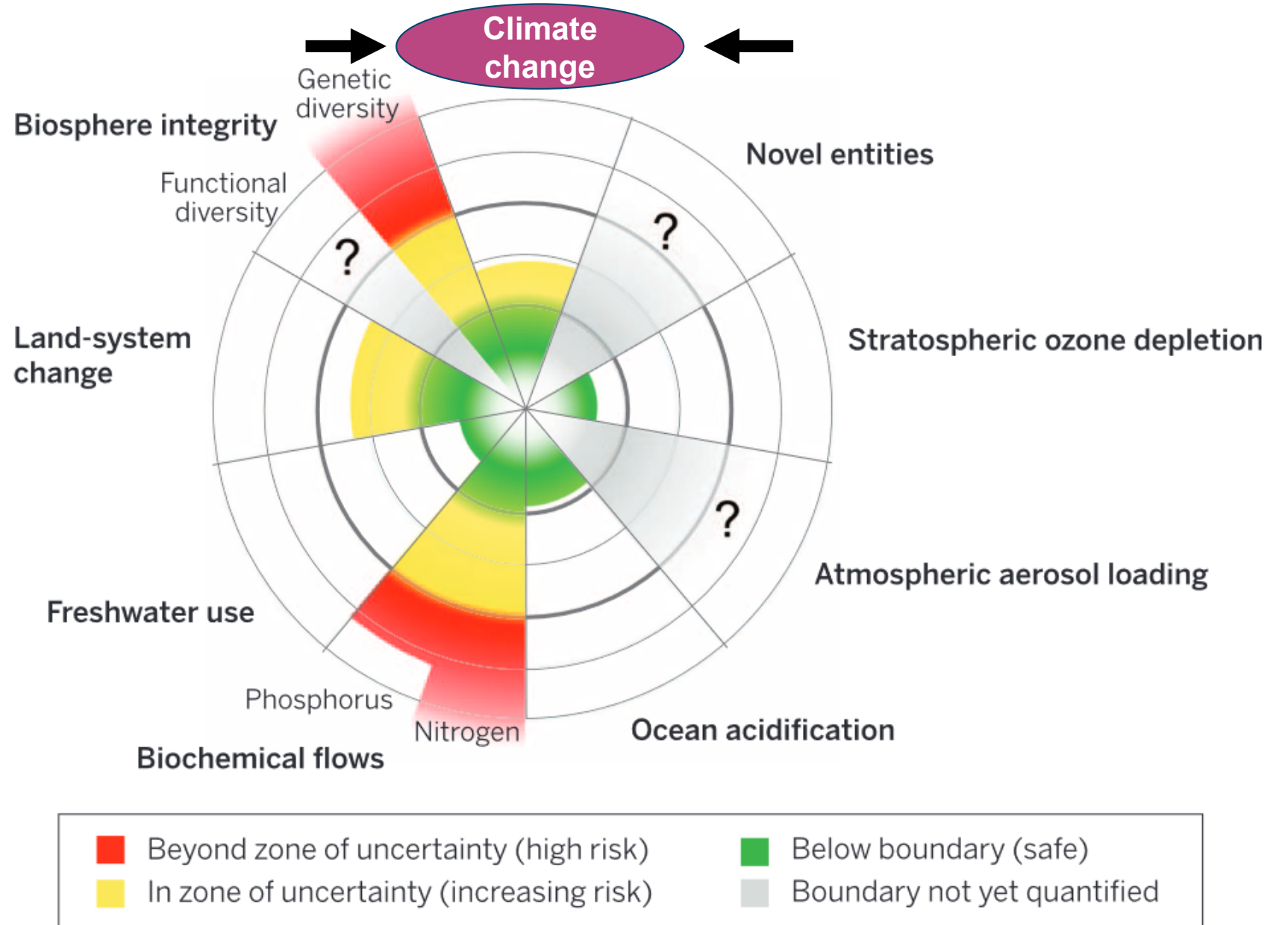
**Paris Agreement (2015):**  
on limiting global warming  
reducing impacts of  
climate change



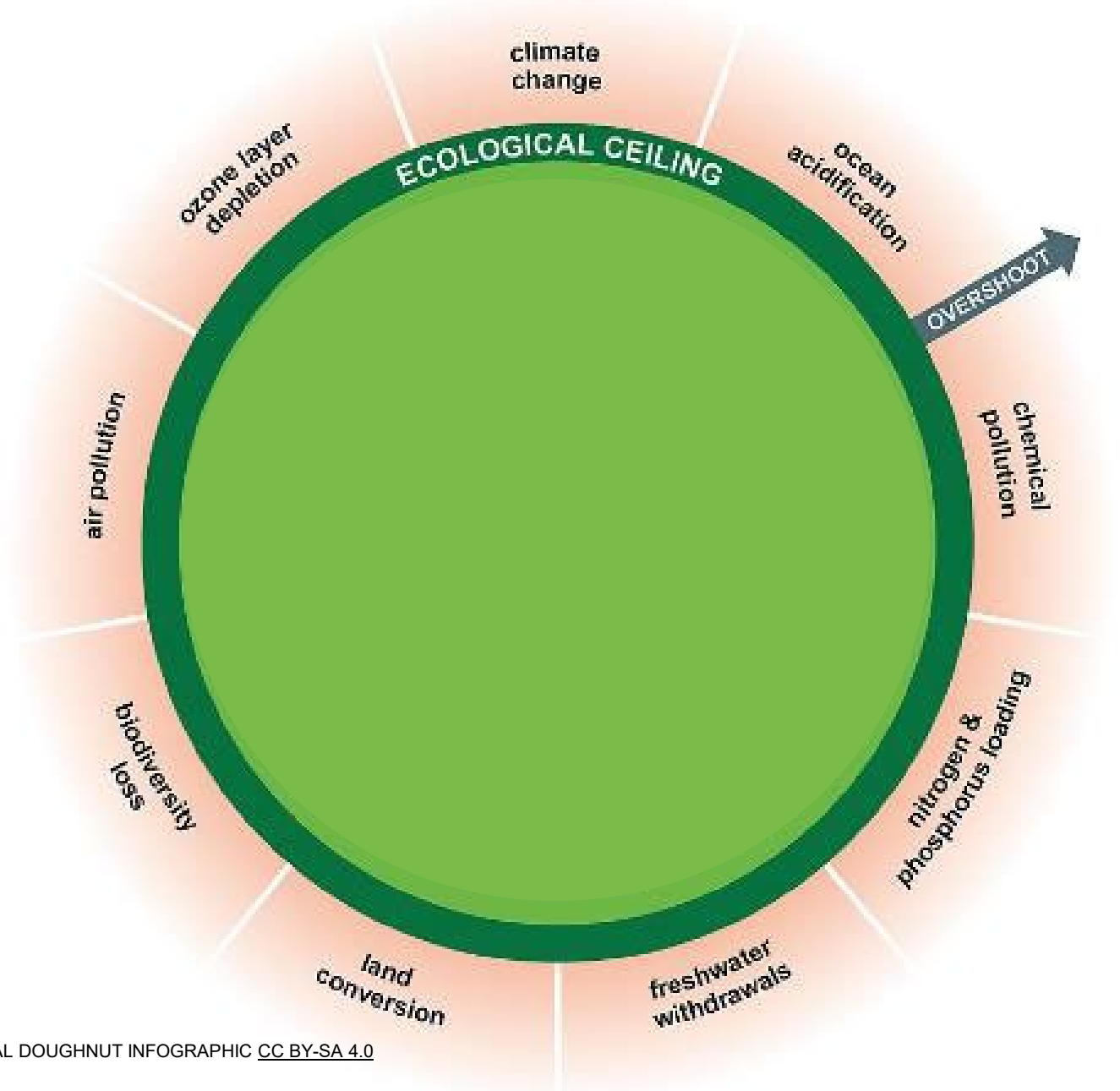
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## Planetary Boundaries:

Ecological ceiling for  
the stress we exert on  
the planet we live on



SOURCE: STEFFEN, W., RICHARDSON, K., ROCKSTROM, J., CORNELL, S.E., FETZER, I., BENNETT, E.M., BIGGS, R., CARPENTER, S.R., DE VRIES, W., DE WIT, C.A., FOLKE, C., GERTEN, D., HEINKE, J., MACE, G.M., PERSSON, L.M., RAMANATHAN, V., REYERS, B., SORLIN, S., 2015. PLANETARY BOUNDARIES: GUIDING HUMAN DEVELOPMENT ON A CHANGING PLANET. SCIENCE 347, 1259855–1259855. [HTTPS://DOI.ORG/10.1126/SCIENCE.1259855](https://doi.org/10.1126/SCIENCE.1259855)



SOURCE: ADOPTED FROM [HTTPS://DE.WIKIPEDIA.ORG/WIKI/DONUT-%C3%96KONOMIE](https://de.wikipedia.org/wiki/Donut-%C3%96konomie) ENVIRONMENTAL DOUGHNUT INFOGRAPHIC CC BY-SA 4.0

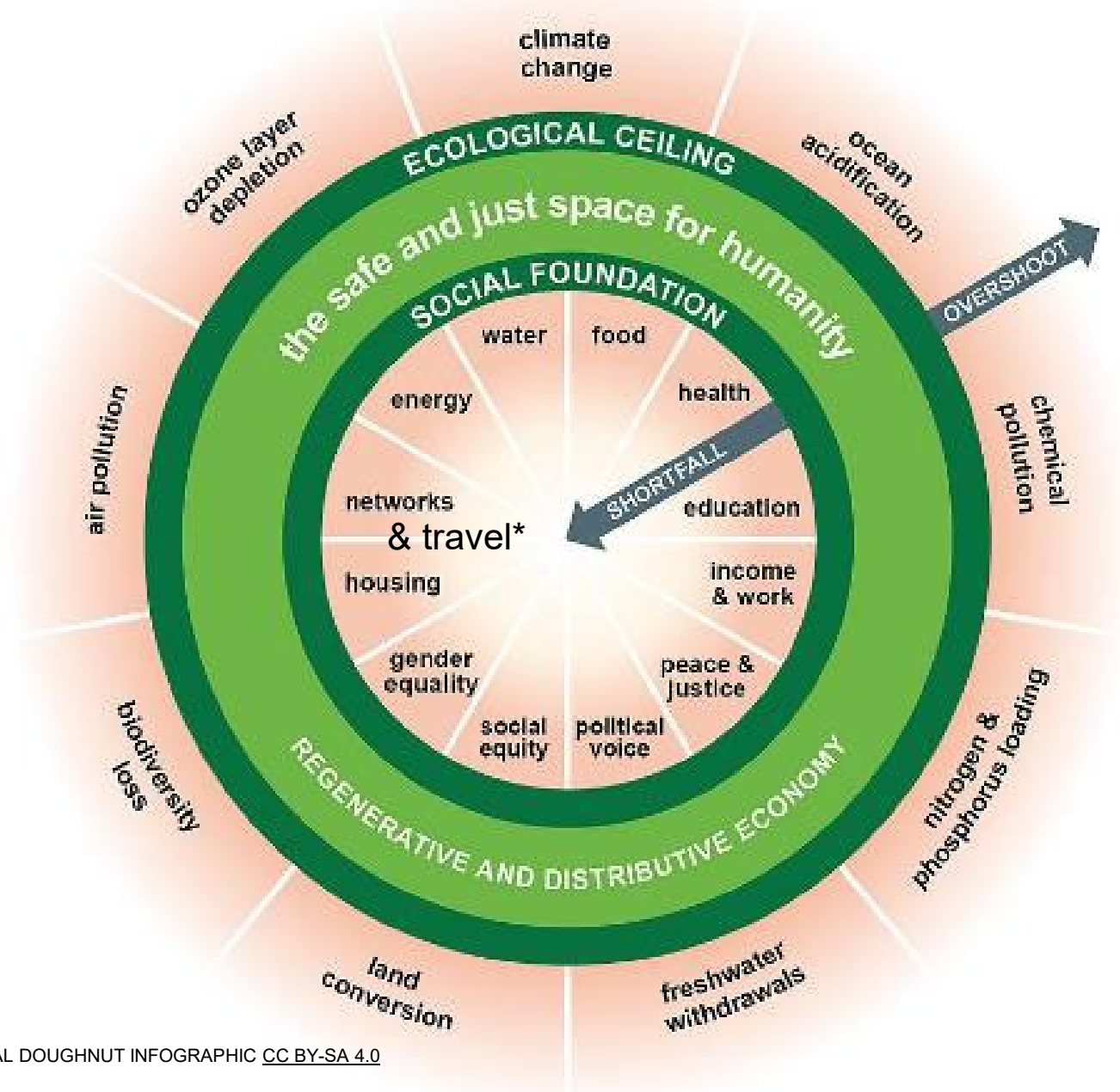
## Doughnut Economy:

Balancing the

ecological ceiling with

a social foundation of current and

future generations



SOURCE: ADOPTED FROM [HTTPS://DE.WIKIPEDIA.ORG/WIKI/DONUT-%C3%96KONOMIE](https://de.wikipedia.org/wiki/Donut-%C3%96Konomie) ENVIRONMENTAL DOUGHNUT INFOGRAPHIC CC BY-SA 4.0

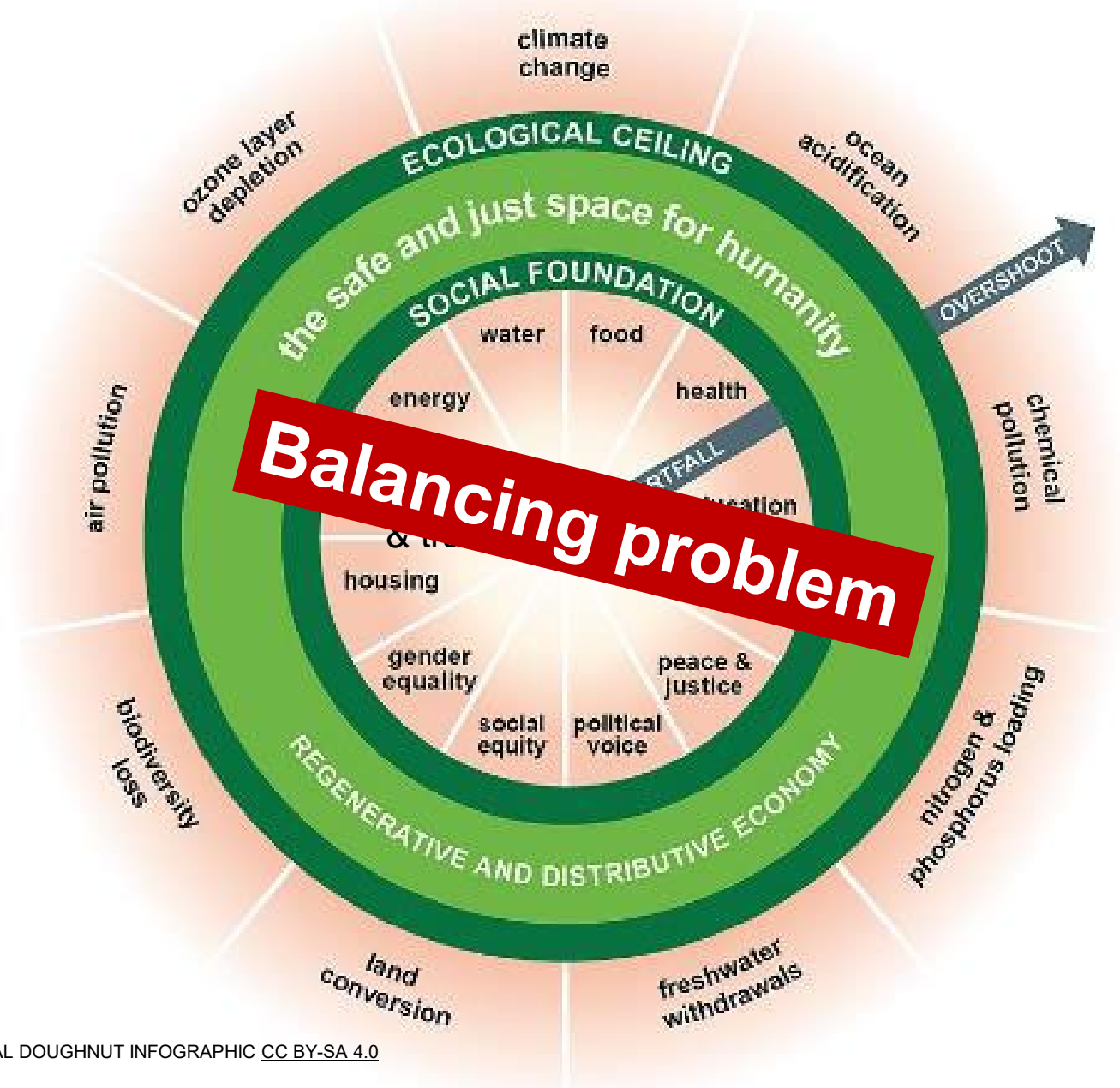
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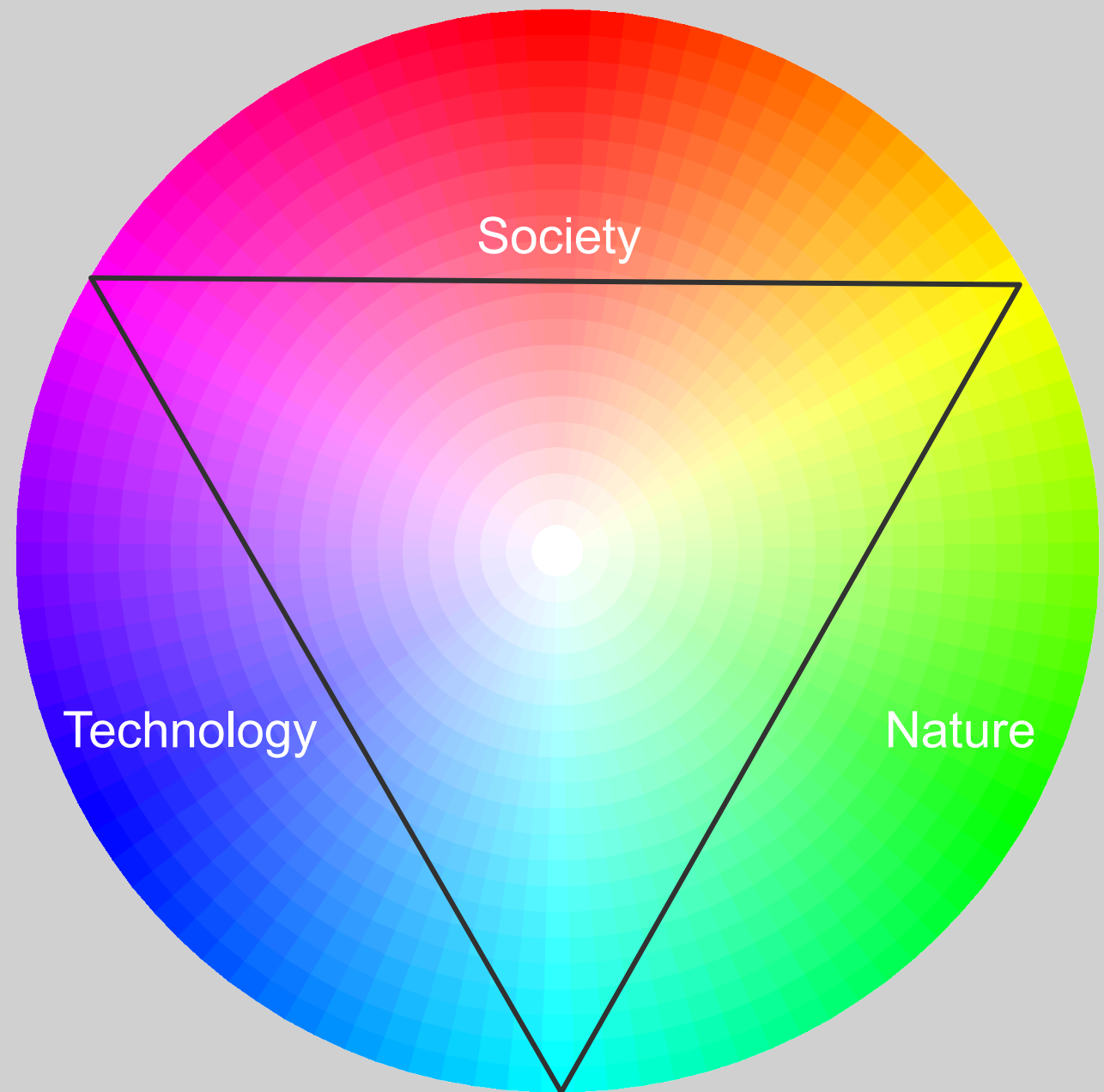
SOURCE: ADOPTED FROM [HTTPS://DE.WIKIPEDIA.ORG/WIKI/DONUT-%C3%96KONOMIE](https://de.wikipedia.org/wiki/Donut-%C3%96konomie) ENVIRONMENTAL DOUGHNUT INFOGRAPHIC CC BY-SA 4.0

**What type of knowledge and knowledge creation is required to inform balancing processes?**



## Common EU Research Classification Scheme:

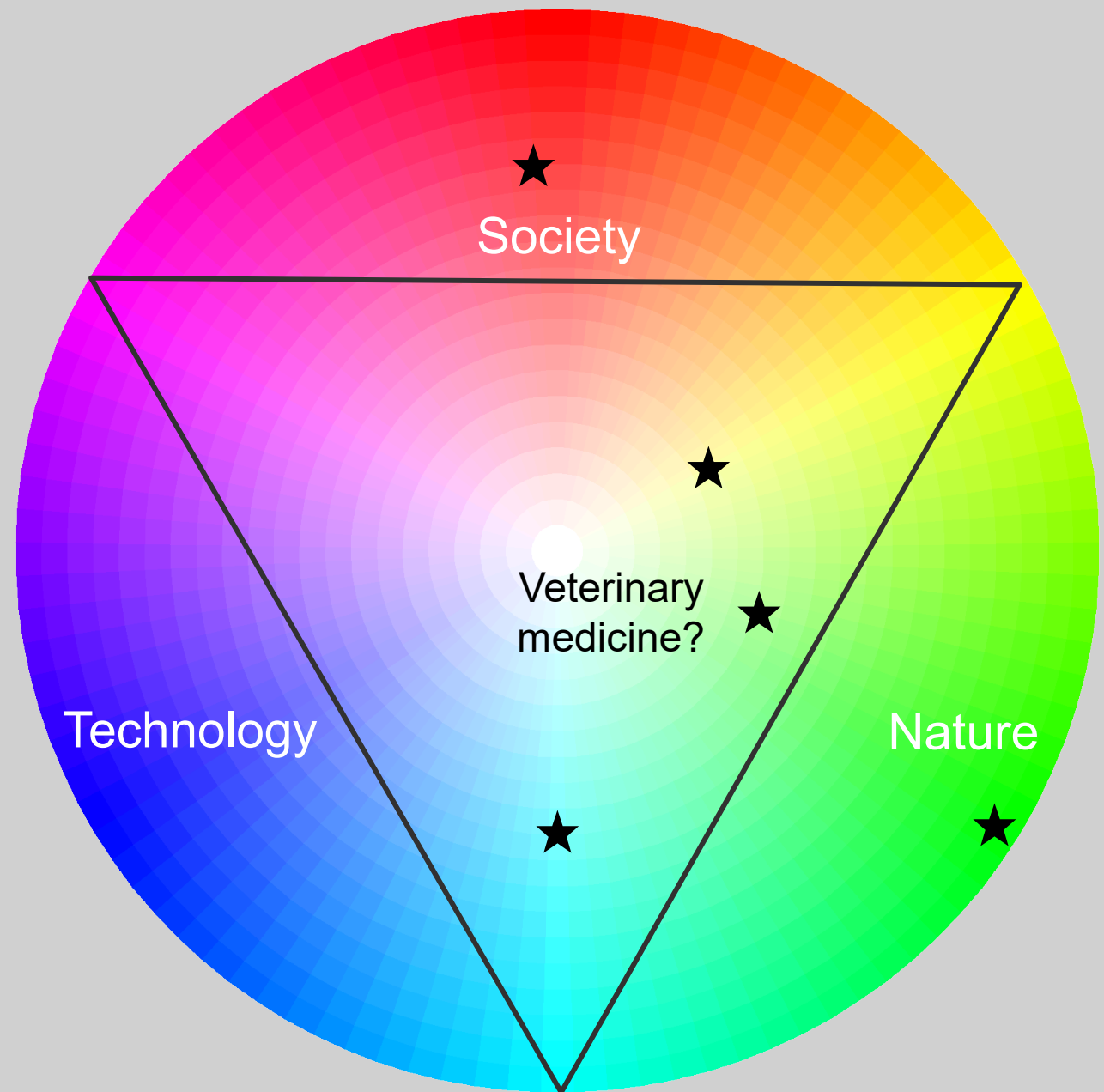
- Humanities (incl. Philosophy, History & Arts, Philology ...)
- Social Science (incl. Law, Economics, Psychology, Pedagogy ...)
- Natural Science and Maths (incl. Physics, Chemistry, Geology, Astronomy ...)
- Biomedical Science (incl. Botany, Medicine, Zoology, Ecology ...)
- Technological Science (incl. Electronics, Construction, Transport, Energy ....)





## Common EU Research Classification Scheme:

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- Technological Science (incl. Electronics, Construction, Transport, Energy .... )





Fabian Schipfer

Scientists 4 Future Austria  
→ Activism & Trans-disciplinarity

Post-Docs (TU, Sapienza, LBNL, TU)  
→ Social Sciences & Inter-disciplinarity

Bioeconomy Start-up (Wien/Vertical Farm)  
→ Industry & Management

PhD in (Renewable) Energy Economics  
→ Technologies & Economy

Master in Physics (Uni Wien, Uni Sevilla)  
→ Reductionism & Environmental Physics







Image:  
<https://www.mcecleanenergy.org/energy-procurement/>



Image: Tesla

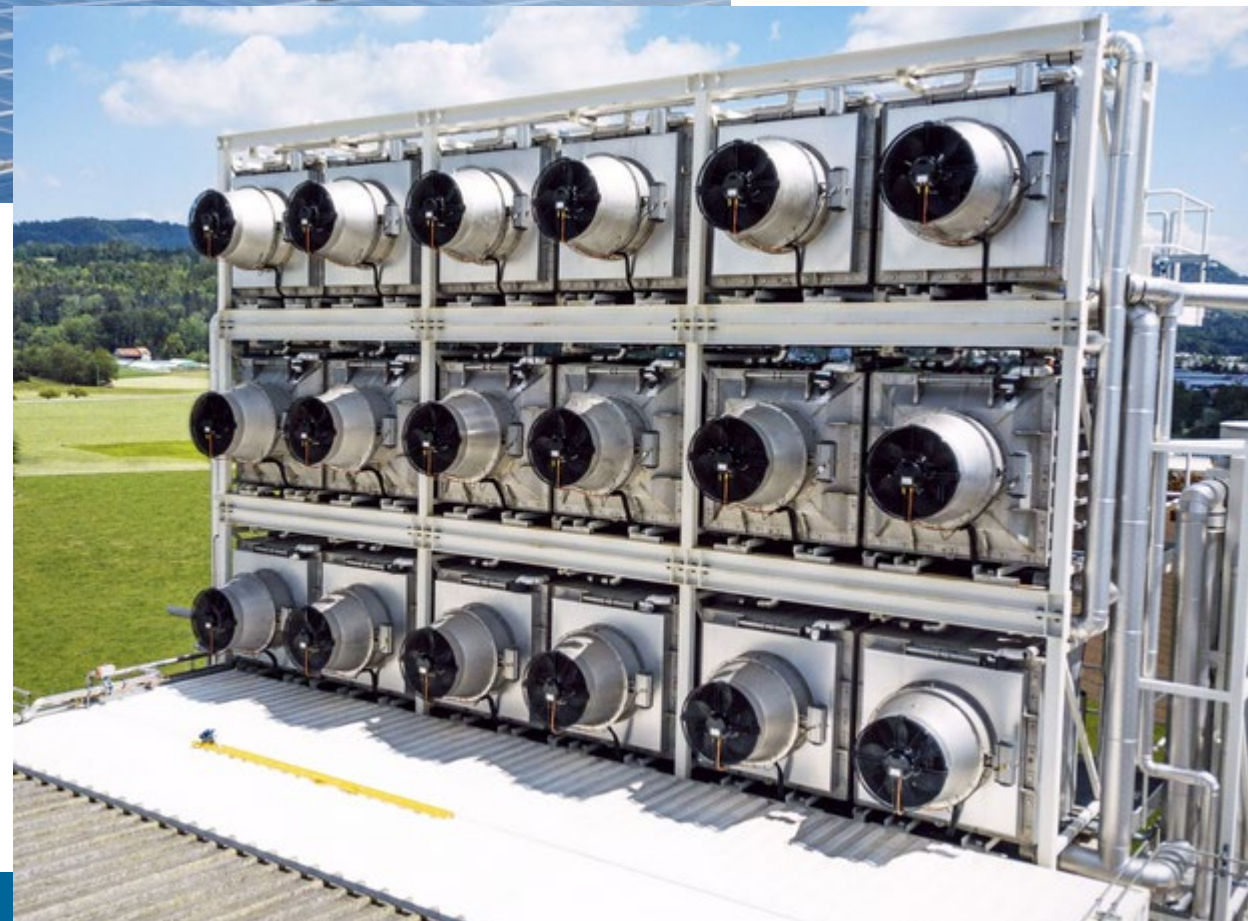


Image: Climeworks





Image by [Matthew Montrone](#) by [Pexels](#)



Image by [Suat iNAN](#) by [Pexels](#)



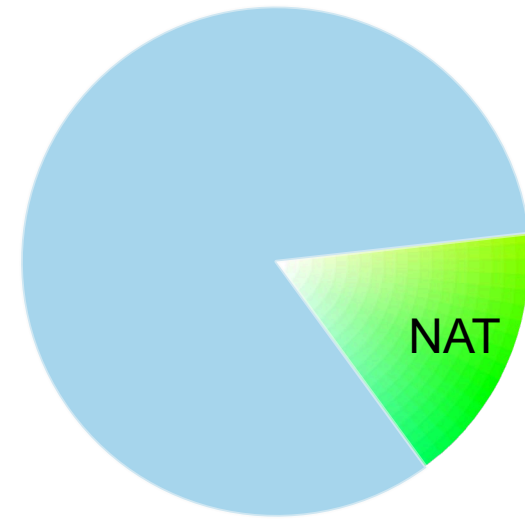
Image by [Johannes Strötter](#) by [Pexels](#)





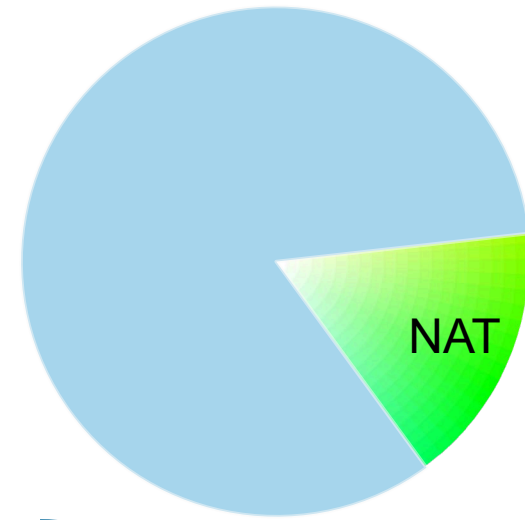
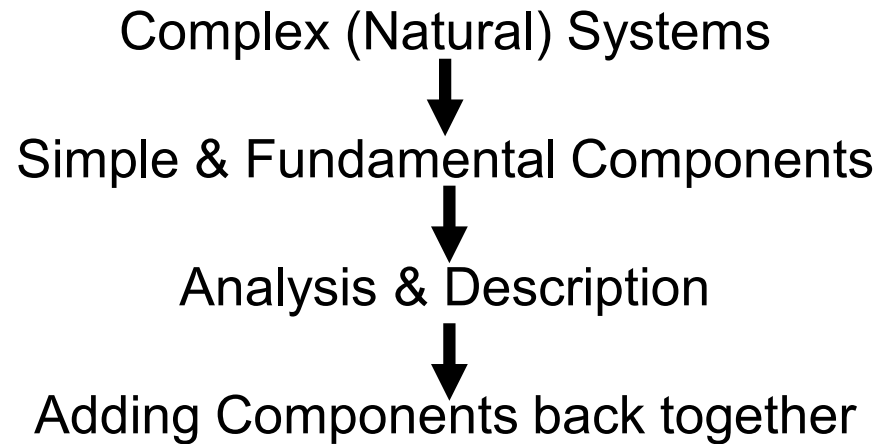
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# Physics Master



# Physics Master

- Classical Mechanics
- Quantum Mechanics
- Electrodynamics
- Thermodynamics and Statistical Physics
- Mathematical Methods



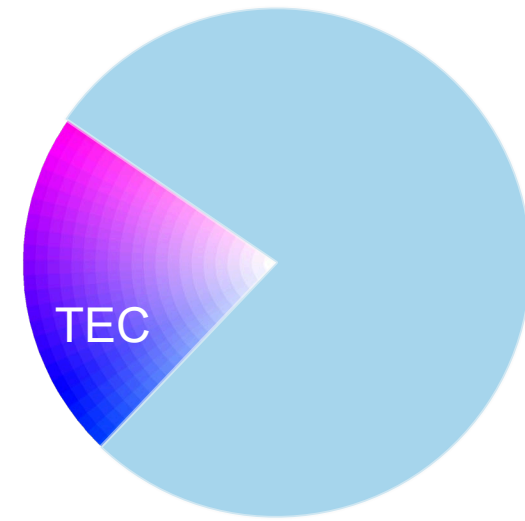
Reductionism

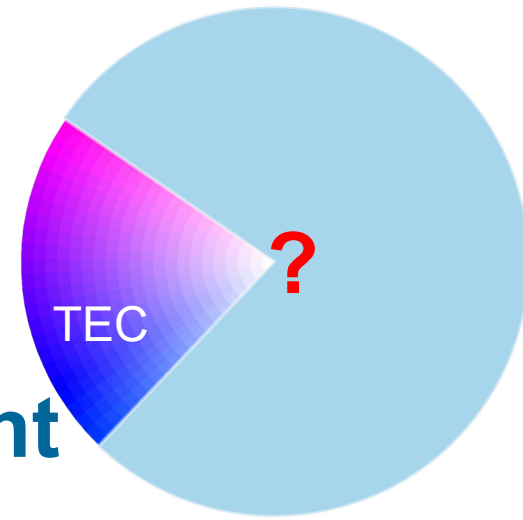


# Economics of ren. energy technologies

## PhD

- Energy & Mass balancing
- Techno-economic assessments
- Econometric modelling
- System framing & scenario modelling
- Limitation awareness





## Example #1 for techno-economic assessment

How to deploy technologies to reduce the costs for substituting oil or gas heating with wood pellet, biogas or bio-oil heating?

→ Bioenergy supply chain

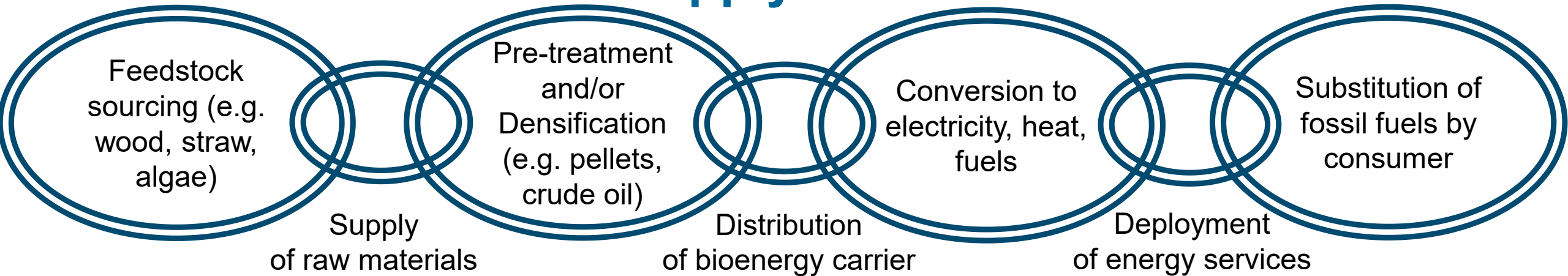
from biomass sourcing (e.g. forest residues)

via \*\*\*\* insert .... technology A \*\*\*\*

via \*\*\*\* insert .... technology B \*\*\*\*

to the substitution of the energy service “residential heating”

# Techno-economic supply chain assessment

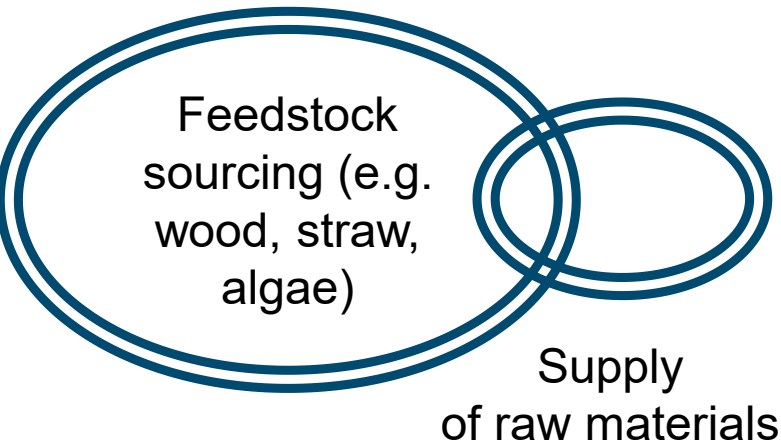
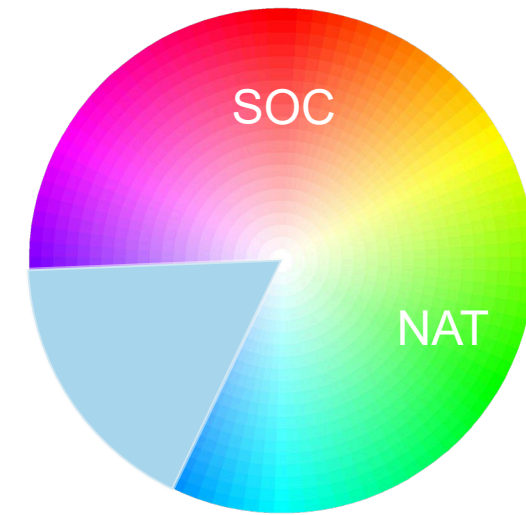


ADOPTED FROM SCHIPFER, F., KRANZL, L., 2019. TECHNO-ECONOMIC EVALUATION OF BIOMASS-TO-END-USE CHAINS BASED ON DENSIFIED BIOENERGY CARRIERS (DBECS). APPLIED ENERGY 239, 715–724. [HTTPS://DOI.ORG/10.1016/J.APENERGY.2019.01.219](https://doi.org/10.1016/j.apenergy.2019.01.219)



## Biophysical processes

- Photosynthesis
- Weather, seasons, geo, climate change



## Ecosystem Services (env. sust.)

- Food/wild food
- Biodiversity/Habitat/Ecotourism
- Regulating Services (CO<sub>2</sub>, albedo, shade, disease/pest, flooding, fire, water, soil erosion)
- Nutrient recycling

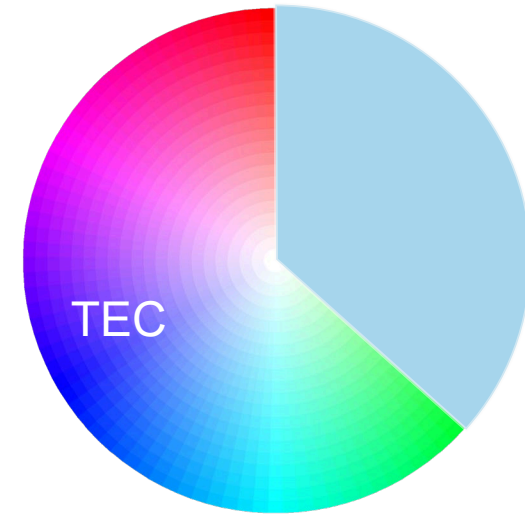
## Societal dimension (soc. sustainability)

- Acceptance → participation (NIMBY → energy communities)
- Jobs & value in rural and/or structurally weak areas
- Land use & ownership structure

### Technical processes

- Conversion efficiencies
- Auxiliary fuel and energy needs
- Infrastructure, transport modes,
- Wastes & sealing of soils

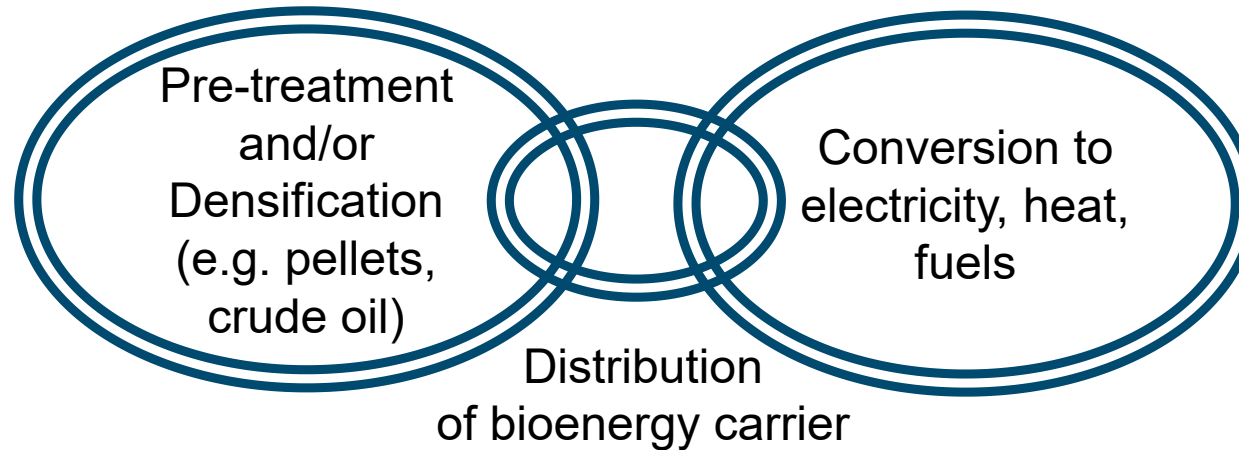
Environmental  
impact



### Economics

- Investment costs
- Operational costs
- Macro-economic assumptions
- Jobs & value
- Stakeholder diversity
- Resource democratization

Social impact

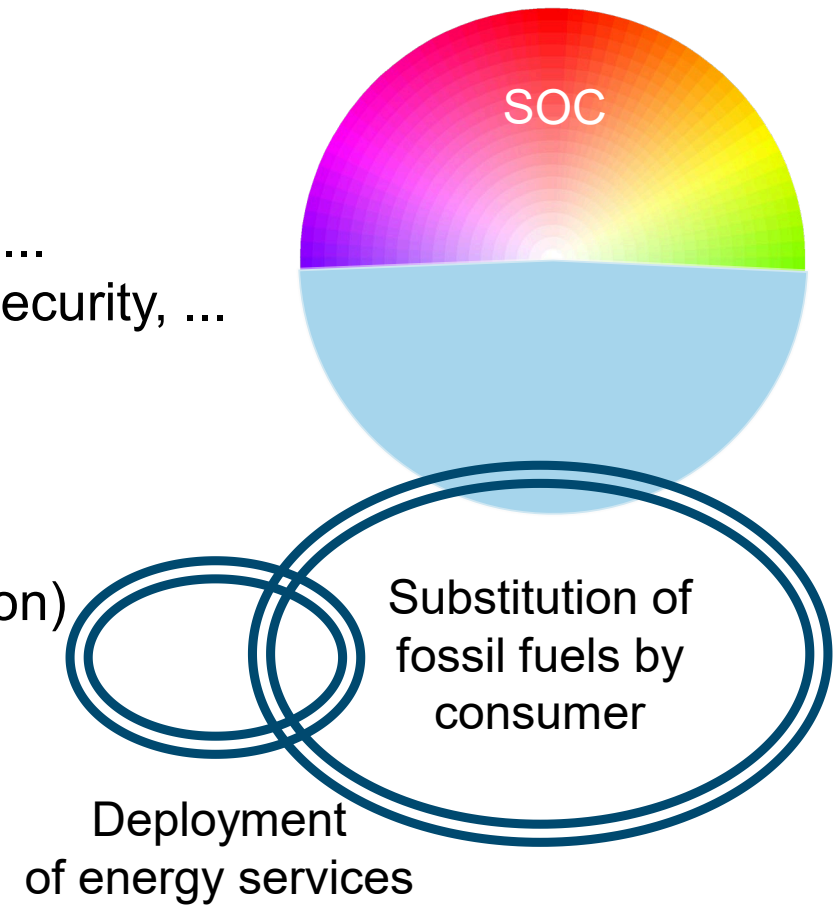


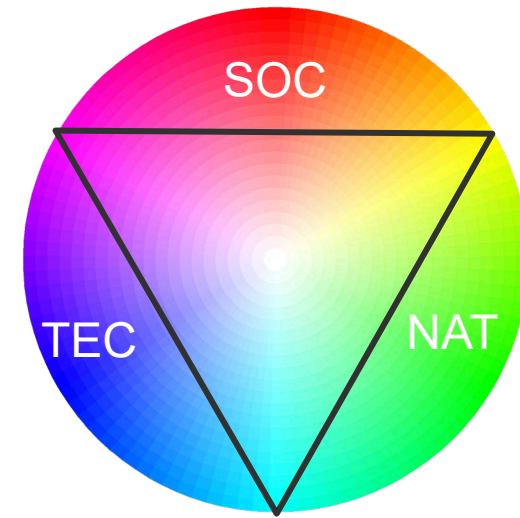
## Socio-economics

- Individual fuel choice depending on economics, information & tech & market access, ....
- Social equity, e.g., have a choice?, investment security, ...

## Trends & dynamics (scenario modelling)

- Macroeconomics – Prices for fossil, CO2, labor, electricity
- Heating & cooling demand (climate change, renovation, population)
- Policies (support, regulatory, cohesion ...)
- Transformation (“landscape”) pressure
- Land use requirements for food & biomaterials  
→ competing demand & synergies (1 + 1 > 2)





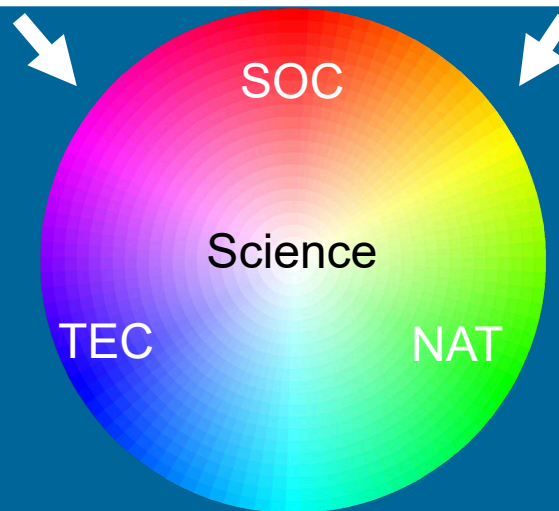
## Example #1 - Conclusions

- Energy system transformation research requires **interdisciplinary integration**  
 == “combination of a wide range of perspectives from different disciplines”\*
- Environmental & social resilience have to be our joint objective function  
 Technological and economic efficiency can only be means to an end
- Reductionism: challenge not to overlook relevant system traits when putting the puzzle back together → balancing reductionism & holism

\*HOFFMANN, S., DEUTSCH, L., KLEIN, J.T., O'ROURKE, M., 2022. INTEGRATE THE INTEGRATORS! A CALL FOR ESTABLISHING ACADEMIC CAREERS FOR INTEGRATION EXPERTS. HUMANIT SOC SCI COMMUN 9, 1–10. [HTTPS://DOI.ORG/10.1057/S41599-022-01138-Z](https://doi.org/10.1057/S41599-022-01138-Z)

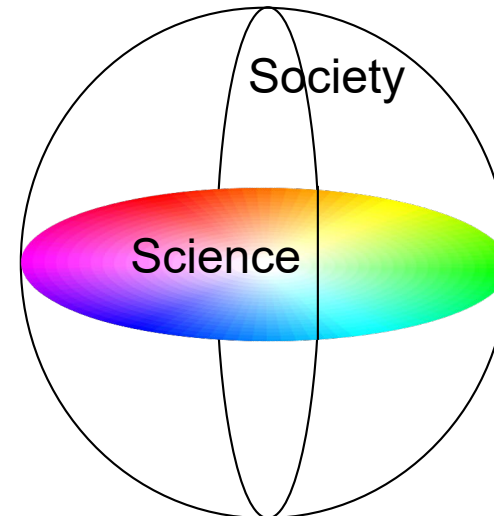


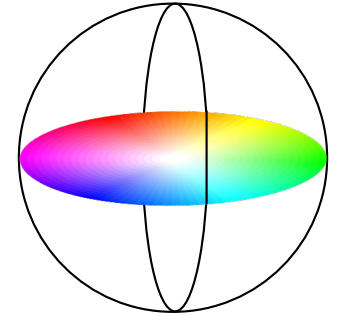
# Does knowledge exist and is knowledge created only within the spectrum disc of science?



# Societal knowledge sphere

- Practitioners possess and create knowledge relevant to framing problems and finding socially robust solutions
  - Work force
  - Technology providers
  - Politicians
  - Organizations
  - Communication experts
  - Educators
  - .....





## Example #2 a trans-disciplinarity effort

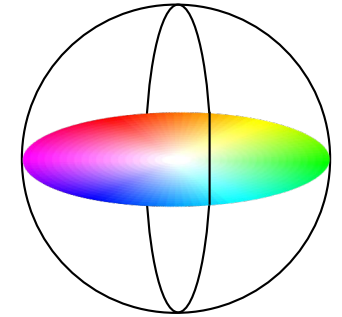
Scientists 4 Future (S4F) Austria

gathering and analyzing perspectives from disciplines & practitioners

facilitating knowledge-flow to everyone who is interested

<https://at.scientists4future.org/>





# Perspectives from science and society

- Broadening the discussion base

"(Irr-)Wege aus der Klimakrise" | Talks for Future vom 1.7.2021

Link kopier...

**Talks for Future**  
"(Irr-)Wege aus der Klimakrise"

**Philipp Steininger**  
Fridays for Future

**Mag. Lukas Hammer**  
Abgeordneter zum Nationalrat, Die Grünen

**Dr. Stefan Gara**  
Abgeordneter zum Wiener Landtag, NEOS

**Univ.-Prof. Dr. Sigrid Stagl**  
Institute of Ecological Economics, WU Wien

**Dr. René Sedmik**  
Atominstitut, TU Wien

**Dr. Fabian Schipfer**  
Energy Economics Group, TU Wien

WEITERE VIDEOS

Moderation: **Philip Pramer**  
Ressortleiter der „Edition Zukunft“ im Standard

0:00 / 1:32:12

@scientists4future.org @scientists4future\_at @Scientists4Future

Factsheet #1

## Factsheet zur Lobau-Autobahn und zugehörigen Straßenbauprojekten

Scientists for Future Österreich ist ein Zusammenschluss von über 1500 Wissenschaftlerinnen und Wissenschaftlern aller Disziplinen, die sich für eine wissenschaftsbasierte Klimapolitik einsetzen.

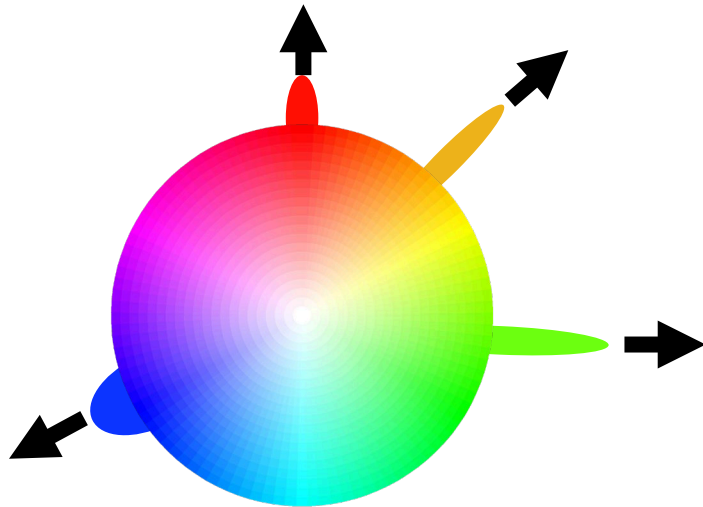
**Mitwirkende:** Barbara Laa (TU Wien), Ulrich Leth (TU Wien), Martin Kralik (Universität Wien), Fabian Schipfer (TU Wien), Manuela Winkler (BOKU Wien), Mariette Vreugdenhil (TU Wien), Martin Hasenhündl (TU Wien), Maximilian Jäger (AustriaTech), Barbara Kovacs, Johannes Müller, Josef Lueger (InGEO Institut für Ingenieurgeologie), Markus Palzer-Khomenko, Nicolas Roux (BOKU Wien)

S4F FACTSHEET ZUR LOBAU- AUTOBAHN UND ZUGEHÖRIGEN STRAßENBAUPROJEKTEN, 2021. BARBARA LAA (TU WIEN), ULRICH LETH (TU WIEN), MARTIN KRALIK UNIVERSITÄT WIEN), FABIAN SCHIPFER (TU WIEN), MANUELA WINKLER (BOKU WIEN), MARIETTE VREUGDENHIL (TU WIEN), MARTIN HASENHÜNDL (TU WIEN), MAXIMILIAN JÄGER (AUSTRIATECH), BARBARA KOVACS, JOHANNES MÜLLER, JOSEF LUEGER (INGEO INSTITUT FÜR INGENIEURGEOLOGIE), MARKUS PALZER-KHOMENKO, NICOLAS ROUX (BOKU WIEN)

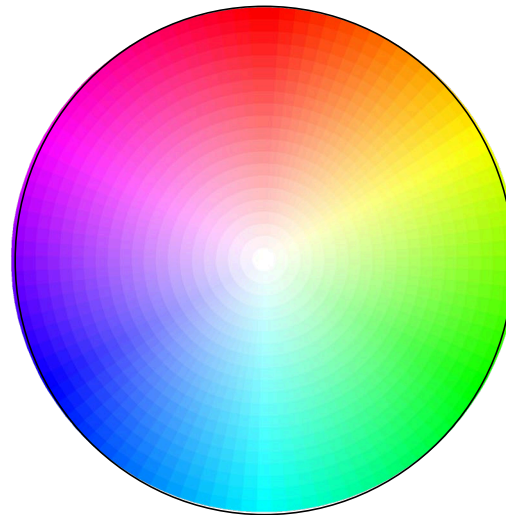
**How can we expand the societal  
knowledge sphere in order to tackle  
our balancing problems?**

# Societal progress based on well integrated scientific progress between disciplines and within society

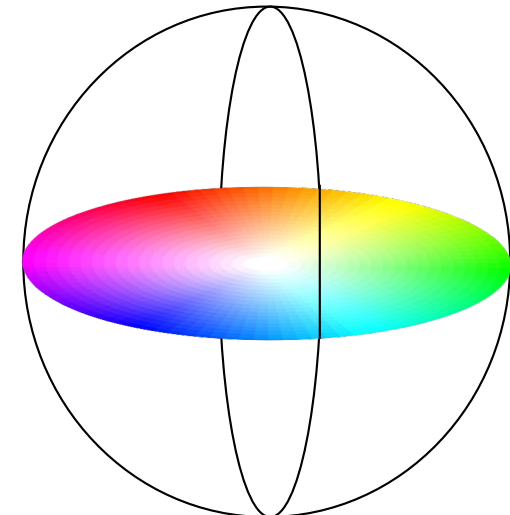
Disciplinary progress



Inter-disciplinarity



Trans-disciplinarity



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# Societal progress based on well integrated scientific progress between disciplines and within society

## Inter-disciplinary progress

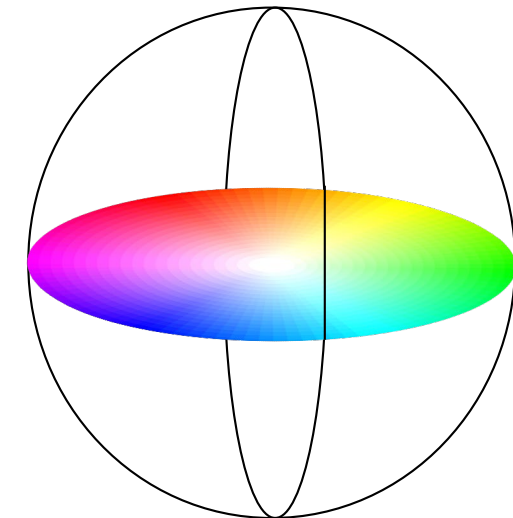
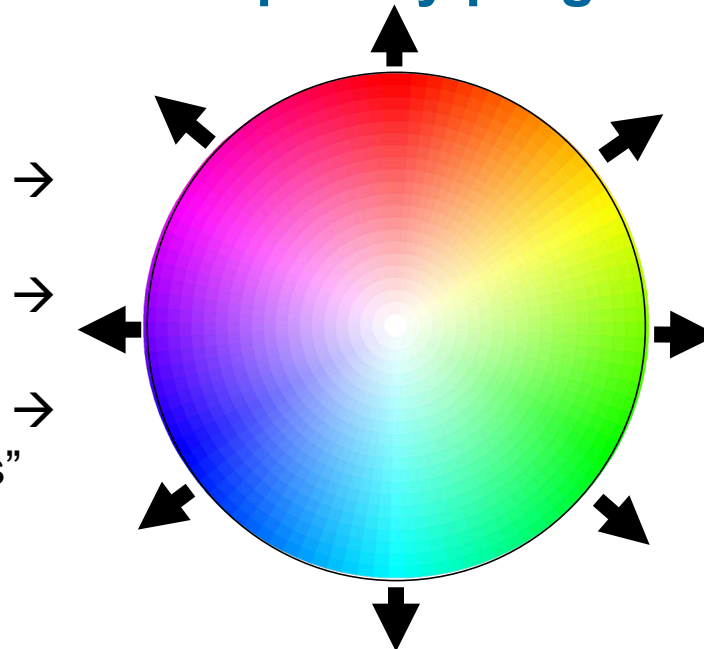
## Trans-disciplinarity

Actively try to fill the gaps

Siloed thinking yes

but also **integrators**

building “wheelchair ramps”  
to & between ivory towers



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# Societal progress based on well integrated scientific progress between disciplines and within society

## Trans-disciplinary progress

Progress with and for all

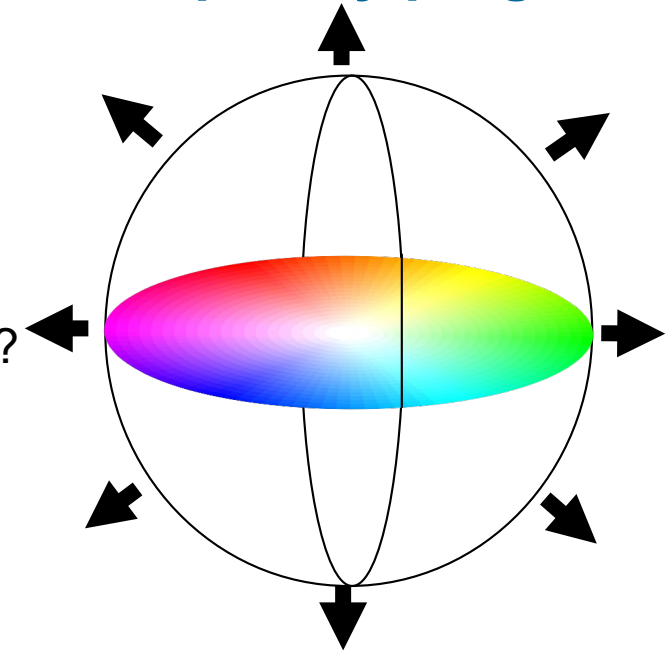
→

Which perspectives do we miss?

→

What's needed to integrate them?

→



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# Selected key requirements for trans-disciplinarity 1/2

- Society → inclusivity ... education, social equity, respect ...
- Language → joint understanding of terminologies and epistemologies
- Big picture → Big **dynamic** picture  
→ connectedness and dynamics of grand societal challenges



# Selected key requirements for trans-disciplinarity 2/2

- Big dynamic picture needs balancing competences;
  - Societal need  $\leftrightarrow$  ecological pressure
  - Reductionism  $\leftrightarrow$  holism/integration
  - Methodological  $\leftrightarrow$  phenomenological
  - Quantitative methods  $\leftrightarrow$  qualitative approaches
  - Results orientation  $\leftrightarrow$  process orientation
  - Efficiency  $\leftrightarrow$  Reliability
  - Conservative/traditional  $\leftrightarrow$  progressive/transformative



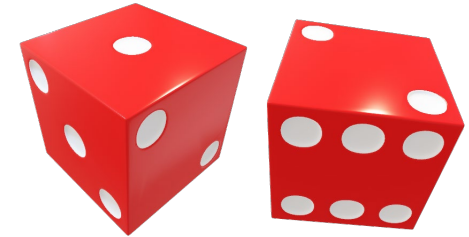
**Inter- & trans-disciplinarity  
== taking risks  
→ gain OR loss**

Foto von Pixabay von Pexels: <https://www.pexels.com/de-de/foto/spielkarten-und-pokerchips-und-wurfel-269630/>

# Inter- & trans-disciplinarity == taking risks

## Potential negative consequences

- loosing the plot / physical and emotional exhaustion\*
- “disciplinary appropriation” (cw., cultural appropriation)
- current scientific structures built around clear categorization and classification\* →
- challenging for publications, proposals, positions/career development

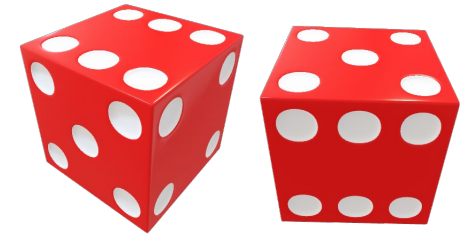


\* Jahn, T., Bergmann, M., Keil, F., 2012. Transdisciplinarity: Between mainstreaming and marginalization. Ecological Economics 79, 1–10. <https://doi.org/10.1016/j.ecolecon.2012.04.017>



# Inter- & trans-disciplinarity == taking risks

## Potential positive consequences

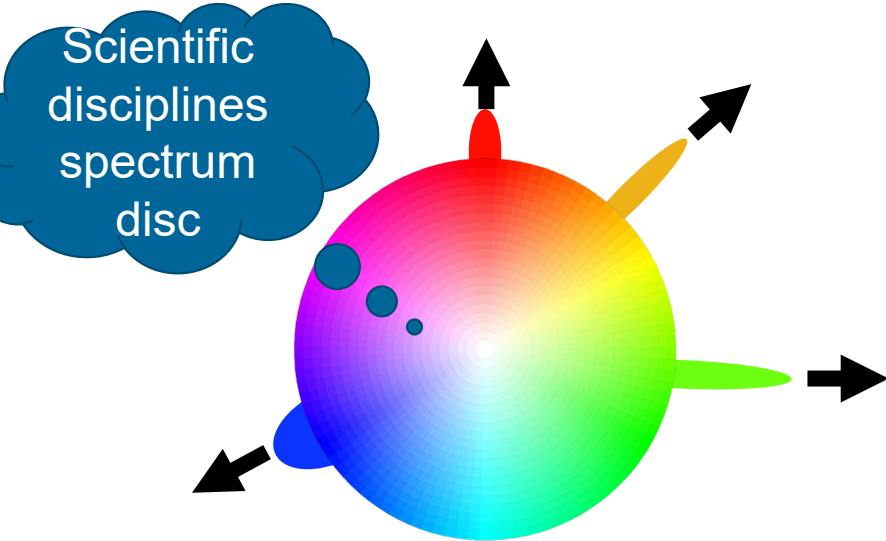


- + Higher impact on science and society
- + Purpose through inclusive problem framing
- + Identification of synergies ( $1+1>2$ ), solving multiple problems at once
- + Epistemological interface → knowledge transfer between disciplines
- + Interaction with a more diverse set of people and perspectives  
→ contributing to own mental resilience and social cohesion
- + subject to scrutiny from different epistemological perspectives\*

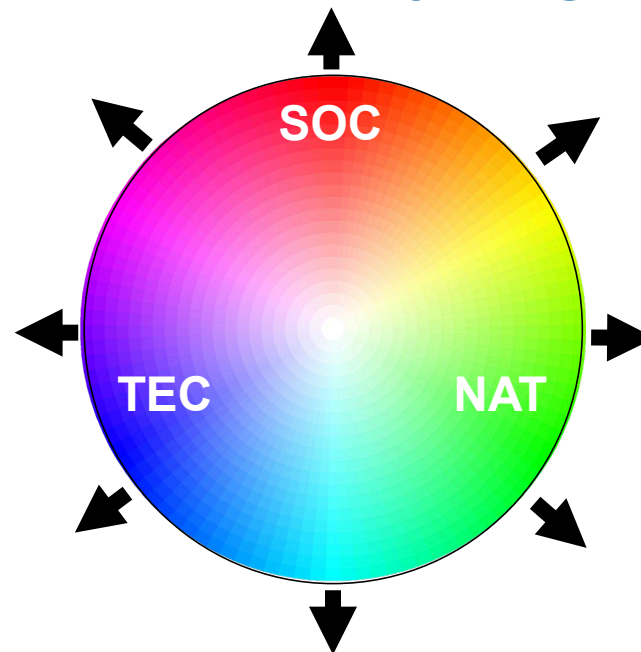
\* Jahn, T., Bergmann, M., Keil, F., 2012. Transdisciplinarity: Between mainstreaming and marginalization. *Ecological Economics* 79, 1–10. <https://doi.org/10.1016/j.ecolecon.2012.04.017>

We have to take the risks of inter- and transdisciplinary integration if we want scientific progress to contribute to progress for all

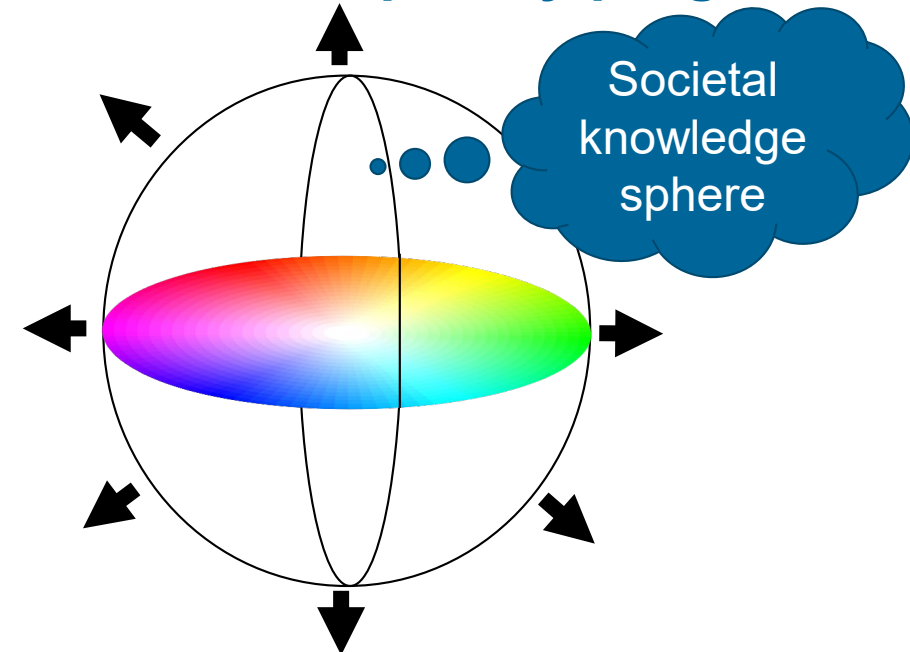
Disciplinary progress



Inter-disciplinary progress



Trans-disciplinary progress



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# Thank you for your attention

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[www.schipfer.eu](http://www.schipfer.eu)

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