Publizierbarer Endbericht

Gilt für Studien aus der Programmlinie Forschung

A) Projektdaten

Allgemeines zum Projekt	
Kurztitel:	SDGVisionPath
Langtitel:	Co-Creating future visions and transition pathways for the SDGs climate action, inequality and decent work and economic growth
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Projekt- und KooperationspartnerIn (inkl. Bundesland):	Die Angewandte, Wien (P1) Paris-Lodron Universität, Salzburg (P2) cooppa Mediengenossenschaft eG, Wien (P3)
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B) Projektübersicht

1 Kurzfassung

Zielsetzung des Projekts

Das Projekt konzentrierte sich auf die Zielkonflikte und Synergien zwischen SDG13 (Klimaschutz), SDG1/10 (keine Armut/weniger Ungleichheiten) und SDG8 (menschenwürdige Arbeit und Wirtschaftswachstum). Um diese Herausforderungen zu bewältigen, schlug das Projekt vor, eng mit Stakeholdern zusammenzuarbeiten und deren Vorstellungskraft und Fachwissen zu nutzen. Die Kombination von partizipativen Ansätzen mit qualitativen und quantitativen Modellbewertungen bietet das Potenzial, die Schwachpunkte der einzelnen Methoden auszugleichen, und robustere und umsetzbare politische Empfehlungen zu entwickeln. Konkret zielten wir auf Folgendes ab:

i. ein gemeinsames System- und Problemverständnis für SDG13, SDG1/10 und SDG8 in Österreich unter den Stakeholdern zu schaffen.
ii. mit den Stakeholdern eine Zukunftsvision zu entwickeln, einschließlich einer Definition von Zielen und Indikatoren zur Messung des Fortschritts.
iii. gemeinsam qualitative Transformationsspfade zu entwickeln und diese mit qualitativen (IPAM) und quantitativen Modellen (iSDG) zu bewerten.
iv. Ermittlung von Hebelpunkten und politischen Empfehlungen.

Methodik und Aktivitäten

Arbeitspaket (AP) 1 erarbeitete ein gemeinsames Systemverständnis durch Anwendung der Causal Loop Diagrams (CLDs) Methode. AP2 nutzte kunstbasierte Methoden, um gemeinsam mit Beteiligten eine wünschenswerte Zukunftsvision und Ziele für 2030/2050 zu entwickeln und eine Umfrage, um Indikatoren für diese Ziele abzuleiten. AP3 wendete Szenariotechniken an, um Pfade zu entwickeln, mit denen die Vision realisiert werden kann. AP4 unterstützte diesen Prozess, in dem die vorgeschlagenen Maßnahmen mit dem qualitativen Modell IPAM und dem quantitativen Simulationsmodell iSDG-AT evaluiert wurden. AP5 unterstützte alle anderen APs durch einen Community of Practice (CoP)-Ansatz. Politische Empfehlungen wurden in einem abschließenden Workshop abgeleitet.

Ergebnisse und Schlussfolgerungen des Projekts

Die von den Stakeholdern in AP1 entwickelten CLDs zeigten bedeutende Synergien zwischen SDG8 und SDG1/10 auf, aber auch bemerkenswerte Trade-Offs zwischen diesen SDGs und SDG13. In AP2 stellten sich die teilnehmenden Stakeholder eine ganzheitliche Zukunft vor, in der Indikatoren jenseits traditioneller Messgrößen wie dem BIP im Vordergrund stehen und institutionelle Ziele wie Bildung und Transparenz einbezogen werden. Die in AP3 gemeinsam erarbeiteten Pfade betonten vor allem soziale und regulatorische Maßnahmen, und weniger wirtschaftliche Instrumente. AP4 und AP5 unterstrichen den Wert

der Wissensintegration durch die Kombination von Erkenntnissen der Interessengruppen mit quantitativer (iSDG-AT) und qualitativer (IPAM) Modellierung. Die IPAM-Analyse im dritten Workshop verdeutlichte die Bedeutung von Gerechtigkeitsaspekten wie Verteilung, Beteiligung und Anerkennung bei der Politikgestaltung. Die iSDG-AT-Simulationen verdeutlichten die Schlüsseldynamiken politischer Interventionen in den Transformationspfaden. Die Ergebnisse zeigten, dass zusätzliche Maßnahmen notwendig sind, um die Klimaziele in Österreich zu erreichen (z.B. Dekarbonisierung der Industrie und der Mobilität) und verdeutlichten mögliche Zielkonflikte zwischen Klimaschutz und Energiearmut. Die abschließenden Empfehlungen der Stakeholder im letzten Workshop unterschieden sich deutlich von jenen, die traditionell von (quantitativen) Modellierungsansätzen empfohlen werden. Der Schwerpunkt lag dabei auf institutionellen Reformen (z.B. verbesserte Governance, Bildung für nachhaltige Entwicklung), regulatorischen Änderungen (z.B. Ausbau der Kinderbetreuung, angemessene Entlohnung, ökosoziale Richtlinien für Werbung, Umverteilung) und Verhaltensänderungen (z.B. weniger Fleischkonsum, Suffizienz-Strategien) und weniger auf typischen ökonomischen Instrumenten wie Preisgestaltung oder Subventionen. Einige Maßnahmen, insbesondere solche, die sich auf den Klimaschutz beziehen, waren unter den Workshopteilnehmenden umstritten (z.B. E-Mobilität, Ausbau der erneuerbaren Energien). Expert:inneninterviews, die nach dem Abschlussworkshop mit dem IPAM geführt wurden, bestätigten diese Ergebnisse und hoben darüber hinaus Maßnahmen hervor, die den Zielkonflikt zwischen Klimaschutz und Energiearmut verringern können, wie z.B. progressive Energietarife und gemeinschaftsorientierte Programme. Konflikte wurden in Hinblick auf eine Ressourcenumverteilung, ökosoziale Steuerreform und eines CO_2-Budgets festgestellt, was die Notwendigkeit eines integrativen und transparenten Governance-Rahmens unterstreicht. Insgesamt kann das vorgeschlagene Maßnahmenpaket zur Erreichung der gemeinsamen Zukunftsvision beitragen.

Ausblick und Zusammenfassung

SDGVisionPath hat gezeigt, dass durch die Anwendung von partizipativen Wissensintegrationsprozessen entlang qualitativer und quantitativer Modellierungsansätze entstehende Synergien genutzt werden können. Jeder der beiden Ansätze allein hätte wichtige Maßnahmen verpasst, die zur Erreichung der SDGs erforderlich sind. Im Hinblick auf die Umsetzung empfahlen die Beteiligten: den Einsatz von Systemdenken und generationenübergreifendem Denken, die Einbindung möglichst vieler Interessengruppen (z. B. durch Bürgerräte), vertikale und horizontale Umsetzung (z. B. Bildung für nachhaltige Entwicklung auf allen Ebenen), Berücksichtigung aller Dimensionen der Nachhaltigkeit und Verringerung sozialer Ungleichheiten (z. B. durch progressive Politikgestaltung). Wenn es die Ressourcen erlauben, könnte zukünftige Forschung durch die Einbeziehung einer für die österreichische Gesellschaft repräsentativeren Gruppe von Stakeholdern und durch eine stärkere Fokussierung auf Hindernisse in der politischen Umsetzung verbessert werden.

2 Executive Summary

Objectives of the project

The project focused on the trade-offs and synergies between SDG13 (Climate Action), SDG1/10 (No Poverty/Reduced Inequalities), and SDG8 (Decent Work and Economic Growth), which are often perceived as conflicting. To address these challenges, the project proposed to work closely with stakeholders, drawing on their imagination and expertise. Combining participatory approaches with qualitative and quantitative modelling assessments offers the potential to overcome the blind spots inherent in each method, and to develop more robust and actionable policy recommendations. Specifically, we aimed to:

i. provide a common systems understanding & problem identification in reaching SDG13, SDG1/10 and SDG8 in Austria among stakeholders.

ii. develop a future vision with stakeholders (what life do we want in 2050?) including a definition of targets and indicators for measuring progress.

iii. co-create qualitative transition pathways with stakeholders and assess these pathways in qualitative (IPAM) and quantitative models (iSDG).

iv. identify leverage points and policy recommendations.

Methodology and activities

Work Package (WP) 1 (What's the problem?) established a common systems understanding using elements of participatory modelling by applying the system dynamics method of Causal Loop Diagrams (CLDs). WP2 (Where do we want to go?) used arts-based methods to create a desirable future vision and goals for 2030/2050 with stakeholders. It also used an online survey to derive targets and indicators that can be used to measure the progress towards the goals. WP3 (How do we get there?) applied scenario creation techniques in a stakeholder workshop to develop narratives of transformation pathways and to realize the vision from WP2 considering the systems understanding developed in WP1. WP4 (What do models say?) supported the previous WPs by evaluating measures identified with the qualitative model IPAM and the quantitative simulation model iSDG-AT. WP5 (Let's co-create) supported all other WPs by applying a community of practice (CoP) approach. Policy recommendations were derived in a final stakeholder workshop.

Results and conclusions of the project

The CLDs developed by stakeholders in WP1 revealed significant synergies between SDG8 and SDG1/10, but also notable trade-offs between SDG13 and these other SDGs. In WP2, stakeholders envisioned a holistic future, emphasizing indicators beyond traditional metrics such as GDP and integrating institutional goals such as education and transparency. The co-created pathways in WP3 highlighted a strong emphasis on social and regulatory measures alongside typical economic instruments such as subsidies and pricing mechanisms. WP4 and WP5 underlined the value of knowledge integration by combining

stakeholder insights with quantitative (iSDG-AT) and qualitative (IPAM) modelling. The IPAM analysis in the third workshop highlighted the importance of justice dimensions such as distribution, participation, and recognition in policy design. The iSDG-AT simulations highlighted key dynamics of policy interventions in the pathways. They showed the need for additional measures to achieve climate targets in Austria (e.g. decarbonization of industry and mobility) and highlighted potential trade-offs between climate action and energy poverty. In the final workshop stakeholders provided policy recommendations and identified implementation issues based on the previous findings. These recommendations differ significantly from those traditionally recommended by (quantitative) modelling approaches, with a focus on institutional reforms (e.g. improved governance, education for sustainable development), regulatory changes (e.g. expansion of childcare, adequate remuneration, eco-social guidelines for advertising, redistribution) and behavioral shifts (e.g. less meat consumption, sufficiency practices), and less on typical economic instruments such as pricing or subsidies. Some measures, especially those related to climate action, were highly controversial among participants (e.g. e-mobility, expansion of renewable energy). Expert interviews conducted with IPAM after the final workshop confirmed these findings and further highlighted measures that can reduce the trade-off between climate action and energy poverty, such as energy literacy initiatives, progressive energy tariffs, and community-focused programs. Conflicts were identified in areas such as resource redistribution, eco-social tax reforms, and carbon budgeting, highlighting the need for inclusive and transparent governance frameworks. Overall, the proposed package of measures offers interventions to harness synergies and overcome the trade-offs identified in WP1 and can contribute to the achievement of the shared future vision and the SDGs studies.

Outlook and summary

SDGVisionPath has shown that by applying knowledge integration processes along qualitative and quantitative modelling approaches, synergies between these approaches can be harnessed. Either approach alone would have missed important measures and leverage points needed to achieve the SDGs. In terms of policy implementation, participants recommended the use of systems and intergenerational thinking: the involvement of as many stakeholders as possible (e.g. citizens' councils), vertical and horizontal implementation (e.g. education for sustainable development at all levels), consideration of all dimensions of sustainability, and a desire to reduce social inequalities (e.g. progressive policy design). If resources allow, future research could be improved by involving a more representative stakeholder group of the Austrian society and by focusing more on barriers to policy implementation.

3 Background and Objectives

The scientific evidence calling for urgent and tremendous action to achieve the Sustainable Development Goals (SDGs; United Nations, 2015) to avoid catastrophic consequences on a global scale is imminent (Alvaredo et al., 2018; Bradshaw et al., 2021; IPBES, 2019; Lenton et al., 2019; Steffen et al., 2018) as we are currently heading in the wrong direction (Allianz Nachhaltige Universitäten in Österreich, 2020; Haberl et al., 2020; Kirchengast et al., 2019; Vadén et al., 2020). In this context climate action (SDG13) should be realized in accordance and in synergy with all other SDGs. In particular, we have focused on the interaction between SDG13 (climate action), SDG8 (decent work and economic growth) and SDG1/10 (no poverty/reduced inequality), as these are often considered to be in conflict (Campagnolo and Davide, 2019; Gagnebin et al., 2019; Wiedenhofer et al., 2020). Addressing conflicts, trade-offs and potential synergies between climate change and other SDGs as well as the vagueness of the SDGs, offers an opportunity for a sustainable transformation: First, the potential for conflict can be reduced by the entanglement of different stakeholder interests and topics (Adger et al., 2014). Second, synergies can be harnessed and trade-offs reduced by implementing policies that take such interactions into account (Klenert et al., 2018). Third, the degree of vagueness of the SDGs may leave room for interpretation and manoeuvre in stakeholder processes (Saiz and Donald, 2017a, p. 1031). This is an important consideration, as many proposed SDG indicators may not measure what they should (Zeng et al., 2020). Therefore, an understandable and appropriate approach is needed that supports stakeholder understanding of the issues at stake and includes the application of holistic systems methods that can adequately address SDG interactions. Embedding stakeholder and expert knowledge in system assessments can enrich the modelling process, broaden the system representation itself, and reduce the gap between models and reality, between imagination and action (Hirsch Hadorn et al., 2010; Kok et al., 2015). Based on a thorough, i.e. stakeholder, expert and model-informed, understanding of the system, it is possible to identify leverage points, i.e. places to intervene in the system, that go beyond simply twisting and tweaking individual parameters (Meadows, 1997).

We aimed to apply a stakeholder-driven holistic systems thinking approach for Austria, considering the interactions between SDG13 (climate action), SDG8 (decent work and economic growth) and SDG1/10 (no poverty/reduced inequality). We combined the application of "Communities of Practice (CoP)" (Wenger, 1999) for stakeholder and expert collaboration with two models that are specifically suited for addressing SDG interactions and for integrating stakeholder and expert knowledge: On the one hand, the quantitative system dynamics simulation model iSDG-AT, which captures the complex interactions between all SDGs (Allen et al., 2019a; Spittler and Kirchner, 2022). On the other hand, the qualitative Inequality and Poverty Assessment Model (IPAM) (Bukowski, 2018; Bukowski and Kreissl, 2022), which enables for the co-creation

of equitable policies and instruments with stakeholders that reflect their socio-environmental impacts. Our specific research objectives (ROs) were:

RO1. Provide a common systems understanding and problem identification in reaching SDG13, SDG8 and SDG1/10 in an Austrian context among experts and stakeholders:

- What synergies and trade-offs exist between these SDGs and why?
- What problems and conflict potentials may arise due to trade-offs?

RO2. Develop a future vision with stakeholders

- What kind of life do we want in 2050?
- What targets and indicators should be used for measuring progress within each SDG?

RO3. Develop transition pathways needed to achieve the future vision:

- Which qualitative pathways can be co-created with stakeholders?
- What insights are created by assessing these pathways in qualitative and quantitative models?

RO4. Identification of policy recommendations to achieve the future vision:

- What leverage points and policy recommendations can be identified based on the findings in the stakeholder collaboration and in the modelling assessments?

4 Project content and results

In this section, we first describe the work activities and then we report our findings from the research process. Both sections are organized according to our work packages (WPs), as we set up a sequential process between the WPs that follows the different steps of our knowledge integration process (see Figure 1). At our project website (https://sdg.visionpath.at/) (i) stakeholder friendly handouts in German regarding workshop results and methods, and (ii) detailed working papers regarding our research findings and methods are available.

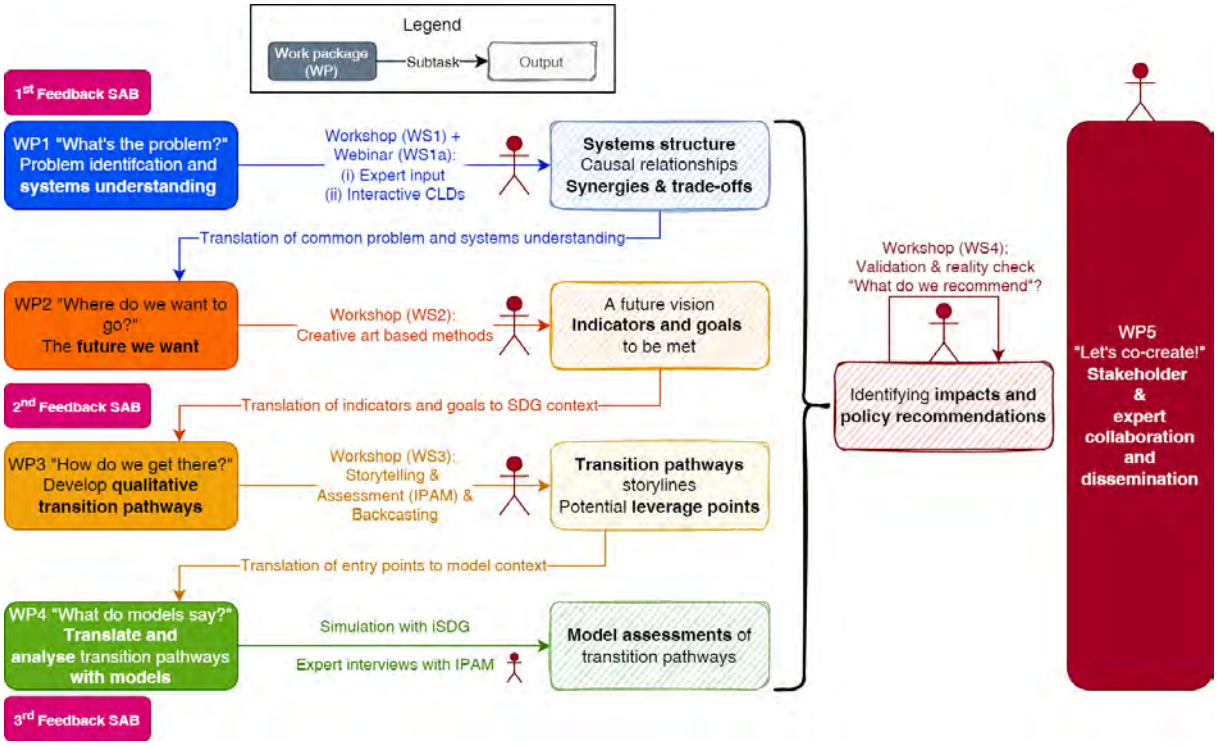


Figure 1: Workflow of work packages.

4.1 Project content

WP1 – Problem identification and systems understanding

WP1 established a common problem identification and systems understanding by applying the system dynamics method Causal Loop Diagrams (CLDs) in workshop 1 (WS1), which took place on 18.01.2023. In a half-day workshop stakeholders developed CLDs to explain the past behavior of the indicators (1) total greenhouse gas emissions (SDG13); (2) greenhouse gas emissions of the building sector (SDG13); (3) real gross domestic product (GDP) per capita (SDG8); (4) work satisfaction (SDG8); and (5) energy poverty (SDG1/10). The research team prepared the workshop, which included a survey asking for the most relevant variables in these systems, and post-processed the CLDs, i.e. digitalization, cleaning them up, and identifying feedback loops, trade-offs, synergies and connections between the individual CLDs. Finally, a webinar

(WS1a) was hosted on 12.06.2023 to discuss the finalized CLDs with the stakeholders.

WP2 – The future we want

Based on the common systems understanding and the problems identified, WP2 included the preparation for the second stakeholder workshop (WS2) on 25.09.2023 for creating a desirable future vision and goals. It applied the art-based method speculative setting in a full day workshop. This included a gamification ("The thing from the future") and a future panel approach. The research term post-processed the workshop results, which also involved the identification of possible indicators for the future vision and goals of the stakeholders. We conducted an online survey, asking stakeholders to assess the suitability of indicators proposed by the research team and to provide, where appropriate, quantitative targets. Based on these, a four-dimensional index was proposed that could show the distance of future realities in relation to the stakeholders' goals.

WP3 – Develop qualitative transition pathways

Based on the future vision of WP2 the research team conducted a third stakeholder workshop (WS3) on 16.11.2023 that included various scenarios techniques to develop qualitative narratives of transformation pathways to achieve the future vision. These techniques included storytelling, assessment of measures with the IPAM model (see also WP4) and backcasting. The outcome of the workshop was a list and assessment of measures to achieve the vision and a timeline of when to implement them. Post-processing included the design of the timeline of the pathways developed in the workshop, a list of measures proposed by the stakeholders and an analysis of the IPAM results.

WP4 – Translate and analyse transition pathways with models

In WP4, two models were applied to support the previous findings. For the quantitative simulation model iSDG-AT activities included (1) establishing a baseline scenario, (2) a check on what can be integrated from WP1 (CLDs), WP2 (indicators) and WP3 (measures) into the model, (3) operationalization of measures and targets in the model, (4) simulation of an SDGVisionPath scenario, (5) preparing the model for interactive simulations during the final workshop, (6) reporting scenario results and analysing synergies and trade-offs. Therefore, the iSDG-AT model was extended by additional model structure and data sources to incorporate new policy instruments and indicators. For the qualitative assessment model IPAM activities included an application in the third workshop and expert interviews in the final stages of the project to evaluate the measures proposed.

WP5 – Stakeholder & expert collaboration and dissemination

In WP5 we applied various activities to ensure a continuous Community of Practice (CoP; Wenger, 1999). This included: (1) creating an overall project design theme and document templates; (2) stakeholder mapping (matrix) and

setting up and maintaining a list of relevant and interested stakeholders and experts; (3) creating a website (https://sdg.visionpath.at/) and maintaining it throughout the project in German and English language; (4) creating a unique email address for the project for direct stakeholder communication and sending out newsletters; (5) general management of stakeholder workshops, webinars and informal meetings; and (6) creation of stakeholder friendly handouts and information booklets explaining the method as well as representing the workshop results for further discussion. Results of the workshops were always sent out to the stakeholders as a stakeholder friendly handout ("Handreichung") and published on the project website. Preliminary research findings and working papers were presented at various national and international conferences. Details on CoP activities are visualized in poster format as *Working Paper 5* (Palmetshofer et al., 2024).

WP6 – Project management

WP6 tasks included the general project management, i.e. organizing project meetings, keeping track of milestones and deadlines, ensuring the publication of project reports and the dissemination of research findings, and the coordination of the Scientific Advisory Board (SAB). The SAB comprised of renowned experts in inter- and transdisciplinary sustainability science: Christian Erik Pohl from ETH Zurich, Peter Victor from York University (CA), Brynhildur Davíðsdóttir from the University of Iceland and Karin Heitzmann from the Vienna University of Economics and Business. Overall, we organized three SAB meetings: a first meeting in November 2022 to receive feedback on the general project idea and the first stakeholder workshop; a second meeting in November 2023 to receive feedback on the current status of the project (mid-term); and a third meeting in May 2024 to receive feedback on preliminary project results and the final stakeholder workshop.

4.2 Project results

WP1 – Problem identification and systems understanding

Establishing a common systems and problem understanding (M1a)

Milestone M1a addressed RO1, i.e. identifying synergies, trade-offs and potential conflicts between the SDG indicators poverty/inequality (SDG1/ SDG10), job satisfaction (SDG8), real GDP per capita (SDG8), and GHG emissions in Austria (SDG13) by applying the method of Causal Loop Diagrams (CLDs) (Barbrook-Johnson and Penn, 2022; Hanger-Kopp et al., 2024; John D Sterman, 2000). This method helps to elicit implicit expert and stakeholder mental models by creating and drawing a system map of causal relationships to explain the behavior of an indicator (typically called "reference mode"). To be succinct we will focus here on the overall CLD. For a more in-depth analysis we refer to *Working Paper 1* (Wretschitsch et al., 2024b).

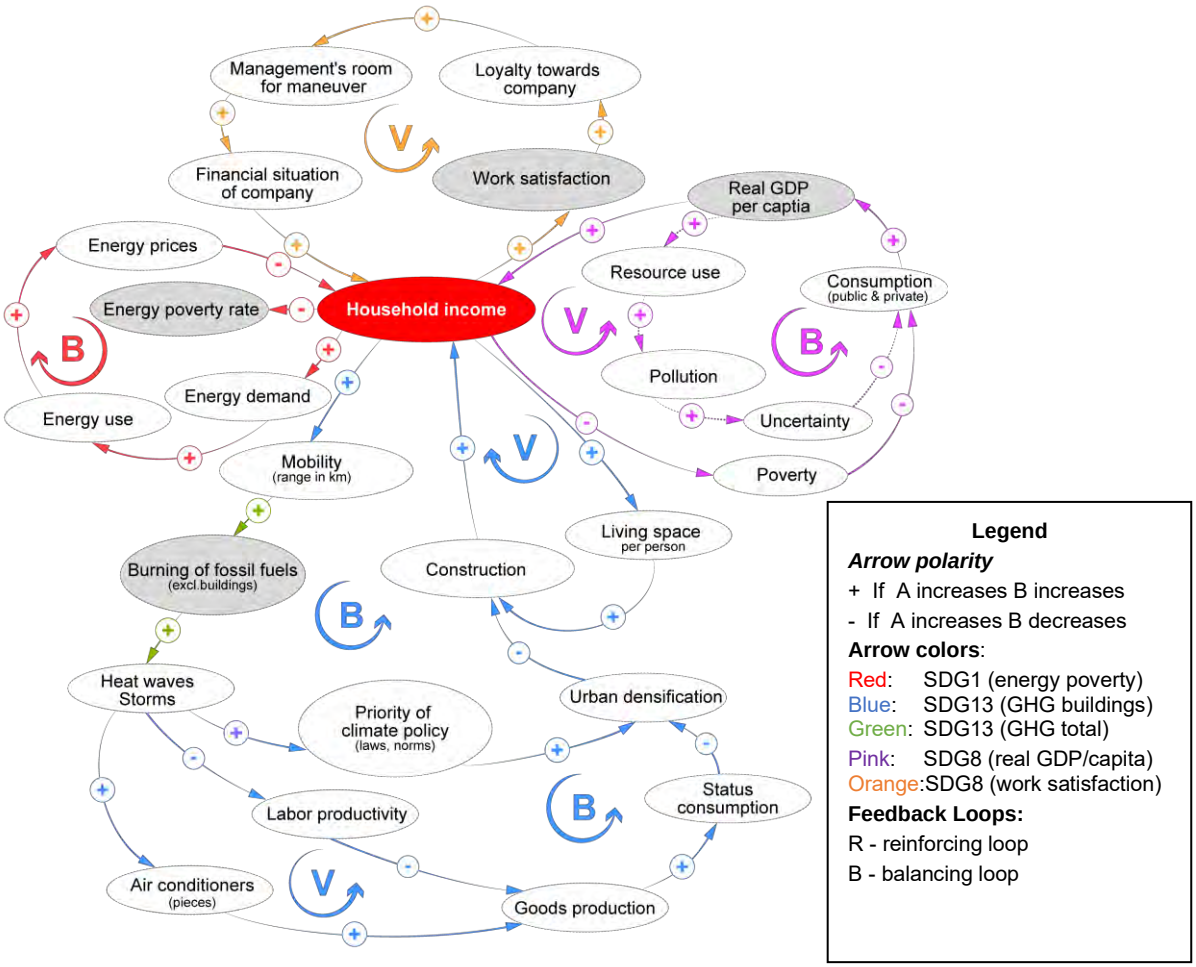


Figure 2: Selected causal chains and feedback loops of the overall CLD

Figure 2 illustrates a simplified version of the overall causal loop diagram (CLD), capturing the essential dynamics of synergies, trade-offs, potential conflicts, and feedback loops identified by stakeholders within the systems under study. A key feature of the CLD is the central role of *household income*, which connects all individual CLDs and the system behavior they address. Based on this CLD, the most significant macro-level synergies and trade-offs, as recognized by stakeholders, are as follows:

- Synergy: Real GDP per capita (SDG 8), work satisfaction (SDG 8), and energy poverty (SDG 1/10) exhibit mutually reinforcing dynamics. A positive feedback loop links real GDP per capita, work satisfaction, and household income. Increases in real GDP per capita or work satisfaction led to higher household income, which further supports economic growth and work satisfaction. Higher household income directly reduces energy poverty, further enhancing progress on SDGs 1 and 10.
- Trade-off: Higher household income results in increased greenhouse gas (GHG) emissions (SDG 13), highlighting a direct conflict between SDG 13 and the other SDG indicators.

While the CLD includes many other synergies, trade-offs, and feedback loops, two additional dynamics stand out:

- Energy Poverty System: Although higher household income initially reduces energy poverty, it also leads to increased energy consumption and higher energy prices. These factors reduce disposable household income and may increase the energy poverty rate. This balancing feedback loop dampens reductions in energy poverty due to a rebound effect.
- Economic System: Another balancing feedback loop reflects stakeholders' perceptions of the adverse effects of pollution on economic growth. Increased real GDP per capita leads to higher pollution levels, which, in turn, negatively impacts real GDP per capita. Moreover, stakeholders expressed uncertainty about whether the negative impacts of climate change on economic growth (e.g., via reduced labor productivity) outweigh the positive effects of climate policies (e.g., through efficiency gains).

Hence, making stakeholders' knowledge and mental models explicit reveals perceived synergies between SDG1/10 and SDG8 but none with SDG13. Furthermore, the impacts of climate change and environmental pollution on real GDP per capita reflect an implicit acknowledgment of "limits to growth". The relationship between income and energy consumption underscores these constraints.

CLDs capture stakeholders' mental models (Hanger-Kopp et al., 2024) and, like scientific models, are simplified representations that omit certain factors and may contain inaccuracies. Nonetheless, the key findings from these CLDs align with scientific literature. For instance, studies have documented the trade-offs between economic growth and GHG emissions (Haberl et al., 2020; Vogel and Hickel, 2023; Wiedenhofer et al., 2020) and between climate action and energy poverty (Fragkos et al., 2021; Priesmann et al., 2022).

WP2 – The future we want

Co-creating a common future vision (M2a)

Milestone M2a aimed to develop a future vision and goals for 2050 by engaging stakeholders through participatory speculative thinking, addressing the first research question of RO2: *What kind of life do we want in 2050?* We employed speculative design as a critical, forward-thinking method. Unlike traditional scenario planning, speculative thinking uses "what if" questions to challenge assumptions, embrace uncertainty, and foster innovation, drawing on the approach by Dunne and Raby (2013). Speculative design shifts focus beyond linear, hegemonic narratives, blending imaginative fiction with fact-based projections to create a space where uncertainty and alternative futures are valued. The workshop integrated three methodological approaches:

1. Speculative Design Workshop: Participants were introduced to speculative thinking through design examples and the game "The thing

from the future", encouraging alternative perspectives and dismantling traditional knowledge hierarchies. Individual and collective activities combined personal insights with group creativity.

2. Futures Panel: This was the core part of the workshop, putting stakeholders into a hypothetical expert group – the "Future Panel" – to represent diverse stakeholder perspectives. Participants worked in groups to explore two key themes from WP1: distributive justice and beyond economic growth.
3. Collage as Knowledge Production: Using collage, the stakeholders visualized their ideas, balancing deliberate creativity and chance to stimulate interdisciplinary dialogue and created a 2050 newspaper supplement. Collaging blended cognitive and sensory processes, fostering exploration of "what if" scenarios that bridged speculative and actionable ideas.

The workshop produced a shared vision linked to the two themes distributive justice and beyond growth. Participants emphasized interdependencies among the SDGs 1, 8, 10 and 13, and additional social goals such as *work-life balance*, *gender justice*, and *care work valorization* as well as ecological goals such as *biodiversity*, and *circular economy* principles. As institutional goals the stakeholders formulated three critical dimensions as essential to achieving the vision: *Education, Transparency, and Community*.

- Education: Holistic and free education was deemed foundational for sustainability, aligning with *SDG4 (Quality Education)* and fostering responsible, critical citizens.
- Transparency: Institutional monitoring of social and environmental indicators and climate audits were proposed to ensure accountability, supporting *SDG16 (Peace, Justice, and Strong Institutions)*.
- Community: Social cohesion, care work, and local engagement were prioritized to achieve sustainable societies, aligning with SDG11 *(Sustainable Cities and Communities)*.

More information is provided in *Working Paper 2a (Hinterberger et al., 2024b)*.

Identifying indicators and targets to measure progress (M2b)

Milestone M2b addressed the second research question of RO2: *What targets and indicators should be used for measuring progress within each SDG?* The project sought indicators that go "Beyond GDP," following the Bellagio STAMP Principles, which emphasize participation in developing sustainability assessment frameworks (Hardi and Zdan, 1997; Shortall et al., 2015). A key insight is that stakeholders, using scientifically prepared information, are best positioned to identify indicators that accurately measure their goals (Zeng et al., 2020). Based on the vision and goals from WP2 stakeholder workshop, social, ecological, and

economic indicators were identified by the research team. The metrics, spanning ecological, economic, and social dimensions, are visualized using a doughnut model inspired by Raworth (2018), ensuring clarity and effective communication. Beyond established indicators such as "adequate heating" (SDG 1/10: energy poverty), "job satisfaction" (SDG 8), "real GDP per capita" (SDG 13), and "greenhouse gas emissions" (SDG 13), stakeholders were invited to evaluate newly proposed metrics reflecting their priorities from the vision and goals. These additions included "hours spent on basic needs" (work-life balance), "gender equality at work," "material footprint" (circular economy), and "soil sealing" (biodiversity). Based on the stakeholders' suggestions on institutional goals to focus on education, transparency, and governance, we proposed indicators such as "education for sustainable development" and "citizen panels."

An online survey was conducted to evaluate if the proposed indicators accurately measure progress and to set target values. For example, stakeholders pleaded for a 2.5-fold reduction in raw material consumption and a 23% increase in leisure activities and time for personal well-being or the reduction of Austria's gender pay gap from currently more than 18 to less than 2% until 2050, while the per capita GDP targets differed greatly between doubling and zero growth (with a large majority favoring the latter). We propose to apply a four-dimensional distance-to-target-index for monitoring the achievement of the targets. More detailed information can be found in the SDGVisionPath *Working Paper 2b* (Hinterberger et al., 2024a).

WP3 – Develop qualitative transition pathways

Co-creation of storylines for qualitative transformation pathways (M3a)

WP3 addressed RO3, specifically: *Which qualitative pathways can be co-created with stakeholders to achieve the future vision?* This involved co-creating transition pathways in a stakeholder workshop. The central question was reframed as: *How do we get there?*

Three methods were applied in sequence during the third stakeholder workshop:

1. Storytelling: Inspired by "Zukunftswerkstatt" (Jungermann and Thüring, 1987; Wright and Cairns, 2011), storytelling helped create detailed narratives for transition pathways.
2. Environmental and Social Impact Assessment (ESIA): This included an Inequality and Poverty Assessment Model (IPAM) to evaluate measures within thematic dimensions like transparency, community, and education (Bukowski and Kreissl, 2022).
3. Backcasting: Based on Dreborg (1996), Robinson (2003) and Robinson et al. (2011) this method organized measures into a timeline extending to 2050, structured around key themes that emerged in the second workshop (community, education, transparency).

Participants developed pathway narratives and identified leverage points, refining their ideas through scenario analysis and storytelling. They scored IPAM dimensions to highlight areas of conflict and improvement, focusing on justice, community participation, and environmental adaptation (see below). These efforts culminated in *"Stories for Change"*, i.e. a timeline of measures and instruments extending to 2050 (Figure 3) which served as inputs for modelling work in WP4 and the final stakeholder workshop.

The outcome of WP3 highlights how stakeholder engagement furthers the achievement of interwoven climate and broader sustainability goals. Contributions from diverse groups, including governmental bodies, businesses, civil society, and local communities, led to the identification of key strategies for environmental, economic, and social sustainability.

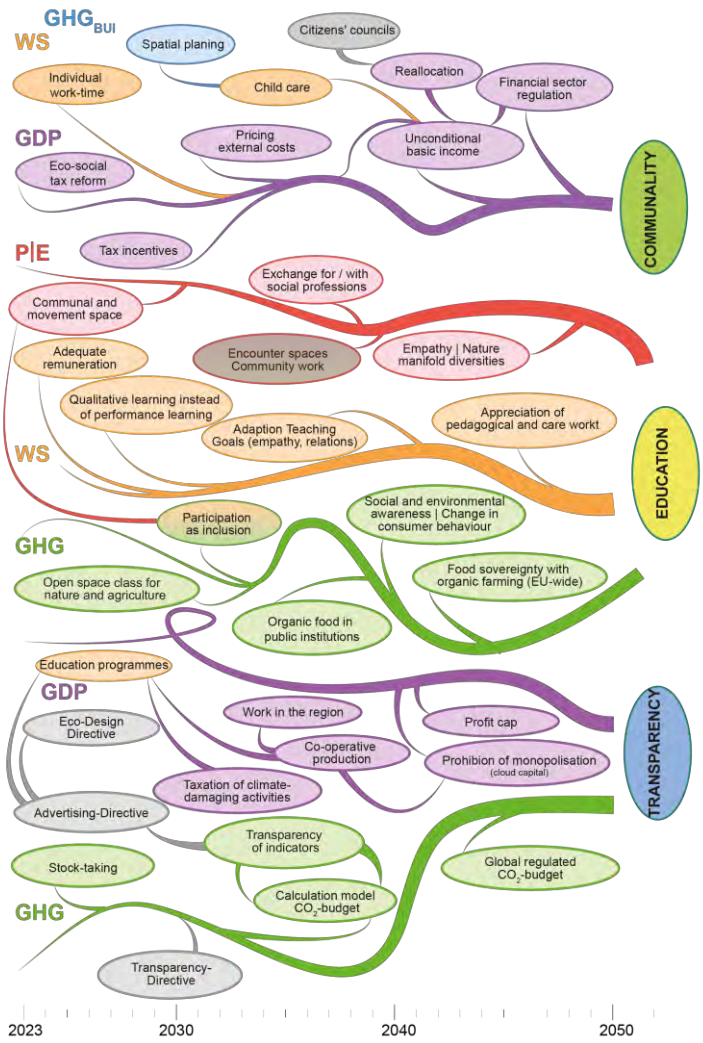


Figure 3: Transformation pathways developed by stakeholders in the third workshop (Source: own)

- Climate Goals and Environmental Sustainability (SDG 13): Stakeholders advocated for eco-social tax reforms, ecological tax incentives, and climate-focused spatial planning. Emphasis was placed on eco-design regulations, organic food programs in public institutions by 2030, and organic farming by 2050. Recommendations also included a binding carbon budget for Austria to meet emission targets.
- Economic Sustainability and Job Satisfaction (SDG 8): Measures proposed included individualized working hours, fair compensation, gender equality in the workplace, and expanded childcare services. Regional employment initiatives and long-term proposals like universal basic income were suggested to reduce economic inequalities.

- Addressing Energy Poverty and Social Inequality (SDGs 1 & 10): Stakeholders highlighted energy efficiency and support for vulnerable groups as key to addressing energy poverty. Eco-social tax reforms and educational initiatives were identified as tools for reducing inequalities, while creating communal spaces was emphasized for fostering inclusion and solidarity.
- Institutional Framework and Governance: Stakeholders recommended participatory decision-making, such as citizens' assemblies, to address equity and environmental adaptation. Suggestions included cost transparency, regulation of climate-damaging activities, and binding carbon budgets.

The outcomes are detailed in *Working Paper 3* (Bukowski et al., 2024b) and informed the modelling work (WP4) for achieving sustainability goals.

WP4 – Translate and analyze transition pathways with models

WP4 addressed both the sub-research question of RO3 (Develop transition pathways needed to achieve the future vision): "*What insights are created by assessing these pathways in qualitative and quantitative models?"* and RO4 (Identification of policy recommendations to achieve the future vision). We applied two models to support stakeholder knowledge integration: (1) the Inequality and Poverty Assessment (IPAM) (Bukowski, 2018; Bukowski and Kreissl, 2022) model to conduct an Environmental and Social Impact Assessment (ESIA) to evaluate measures proposed by stakeholders and (2) the System Dynamics based iSDG-AT model (Allen et al., 2019a; Pedercini et al., 2018a; Spittler and Kirchner, 2022) to simulate the impacts of the transformation pathways developed in the third workshop.

IPAM results

Applying IPAM in the third stakeholder workshop (M4a)

The Inequality and Poverty Assessment (IPAM) model can be applied to conduct Environmental and (Social) Impact Assessments (ESIA). This can highlight potential conflicts and challenges associated with implementing policy options, offering insights into the complexities of achieving Sustainable Development Goals. Designed and applied to analyze SDG-related issues of concern, the IPAM follows a multidimensional approach that is based on a previous design of a Conservation Justice and Conflict Modell (CJC) (Bukowski, 2018), with the emphasis on five recurring justice dimensions mentioned in the relevant scientific literature to reduce poverty and inequality, i.e.: distribution, participation, legitimacy, recognition, and fair climate and environmental adaptation. For more details on the model see *Working Paper 4a* (Bukowski et al., 2024a) and for detailed IPAM workshop results see *Working Paper 3* (Bukowski et al., 2024b).

The third stakeholder workshop applied the IPAM framework to evaluate policy measures addressing socio-economic and environmental challenges, focusing on the IPAM dimensions and identifying conflict potentials:

(1) Distribution: Stakeholders proposed eco-social tax reforms, external cost internalization, and unconditional basic income to enhance redistributive justice. Cooperative living, shared housing, and public awareness were emphasized, but challenges like rising land costs and resistance to tax reforms persisted. Transparency was prioritized, with calls for fair carbon budgeting and price caps on essentials.

(2) Community (Participation): Active participation was encouraged through initiatives such as neighborhood centers, gardening, and buddy programs. Suggested tools included financial compensation for engagement, simplified language for accessibility, and childcare support to foster inclusivity.

(3) Legitimacy/Legal Framework: Enhancing accountability involved proposals for a "law on responsibility" and integrating empathy and relationship skills into education systems. Anticipated resistance included shifts from performance-based evaluations and lobbying transparency. Stakeholders also stressed the need for global carbon budgeting regulations.

(4) Recognition: Addressing diverse needs, including care work and non-Western knowledge systems, was central. Suggestions included curriculum adjustments and work-hour flexibility, although challenges in diversifying education and meeting vulnerable groups' needs in climate adaptation were noted.

(5) Fair Climate and Environmental Adaptation: Eco-social tax reforms were seen as crucial for equity in adaptation. Proposals included awareness campaigns via citizens' councils, sustainable practices in education, environmental taxes, eco-design standards, and improved communication on environmental issues.

Several conflicts were identified in implementing these measures, particularly in resource redistribution, eco-social tax reforms, and carbon budgeting due to socio-economic concerns. Challenges included rising land costs, fair educator compensation, and resistance to non-traditional education systems. Regulatory changes in the financial sector, transparency, and the needs of vulnerable groups, especially those with disabilities, also posed difficulties. The main conflicts centered on broad societal changes, requiring the dismantling of existing power structures to ensure inclusiveness and equity. In conclusion, conflict potentials are most acute with respect to redistribution of resources, adaptation measures requiring broad societal changes, and shifts in regulatory frameworks challenging existing power dynamics.

Validating and evaluating transition pathways with IPAM (M4d)

The second IPAM application aimed to validate and evaluate previous work package outcomes, aligning SDG1/10, SDG8, and SDG13 with new stakeholder-

driven dimensions: Transparency (SDG16), Education (SDG4), and Community (SDG10/SDG11). These were grouped into four thematic clusters: (1) Energy Poverty & Community, (2) GHG Emissions & Education, (3) Job Satisfaction & Education, and (4) GDP & Transparency. These clusters, along with the IPAM dimensions, guided expert evaluations of WP3 measures. The evaluation aimed to validate workshop findings and propose additional measures. Experts from four key groups—government, businesses, NGOs, and academia—participated in 45-minute interviews. A total of 153 points were allocated to assess the socio-ecological conflict potential across five IPAM dimensions (see Figure 4).

(a) Validation of workshop findings: Both experts and workshop participants identified "Distribution" (46 points) as having the highest conflict potential, followed by "Legitimacy" (41 points) and "Fair Climate and Environmental Adaptation" (34 points). In contrast, "Participation" (18 points) and "Recognition" (14 points) were seen as having lower conflict potential. Notably, both groups assigned less conflict potential to social measures within "Participation" and "Recognition," diverging from previous model applications where intersectional issues in "Recognition" were considered significant conflict factors.

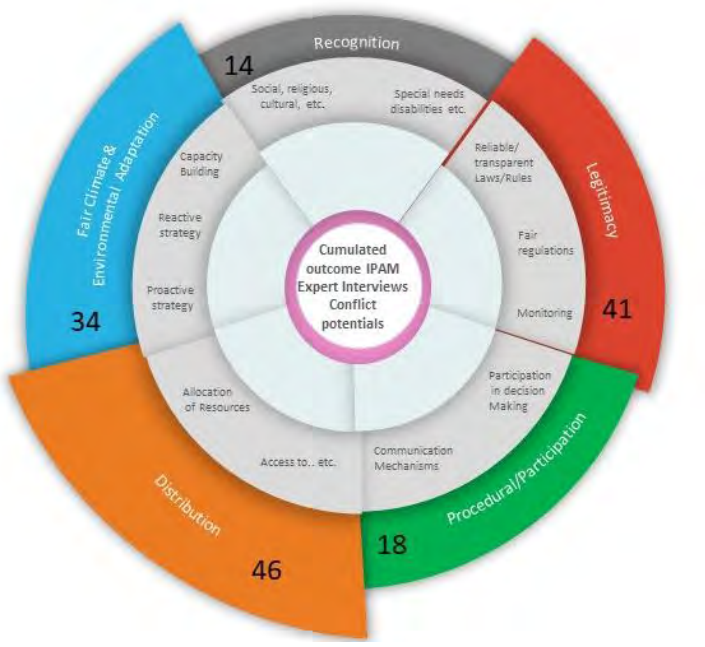


Figure 4: IPAM - Cumulated outcome of expert's evaluation and assessment of conflict potentials

(b) Proposal of additional measures: The following presents the qualitative results of the expert interviews. The findings focus on the measures and ideas proposed by experts, who were not involved in the research project's workshops, to evaluate and enhance the stakeholder outcome. First, we list key issues and measures proposed by experts regarding energy poverty, greenhouse gas emissions, job satisfaction, GDP and transparency. Second, we highlight conflict potentials.

(1) Key issues and measures:

Energy Poverty & Community: Experts recommend progressive energy tariffs to ensure basic energy security, reduce CO_2 emissions, and discourage overconsumption. Subsidies for decentralized Renewable Energy Communities (RECs) are proposed to foster local sustainability. Clear legal frameworks with simplified regulatory processes could enhance trust. Poverty advocacy collaboration should be applied for fair pricing models. A basic energy guarantee is suggested to align social and environmental goals, alongside educational initiatives and solidarity-driven events to engage disadvantaged groups, despite concerns about energy efficiency in low-income households. Promotion of Renewable Energy Communities (REC) is proposed to foster local sustainability and diversify energy sources. The development of the social tariffs should involve collaboration with poverty advocacy groups to ensure inclusivity and fairness. Legal measures are necessary to establish clear frameworks for pricing models. GHG Emissions & Education (Energy-efficient Buildings): Inclusive refurbishment projects targeting low- and middle-income households should be prioritized to improve energy efficiency. Experts emphasize integrating energy literacy into early education and providing practical training in collaboration with companies. Accessible educational materials (such as pictograms and barrier-free resources) and legal frameworks are needed to embed energy efficiency in educational curricula and improve public awareness.

Job Satisfaction & Education: Experts propose aligning sustainability with job satisfaction through expanded workplace training, updated vocational curricula, and experiential learning partnerships between schools and industries. Co-creative curriculum development, inclusive training programs, and a focus on Corporate Social Responsibility (CSR) and inner development goals (IDGs) are emphasized. These efforts aim to balance environmental goals with professional satisfaction while addressing potential challenges in adapting organizational and legal frameworks.

Transparency & GDP: The findings highlight the need for carbon budgeting on a per capita basis and revised GDP metrics to reflect environmental and social costs. Legal frameworks and participatory mechanisms are essential to ensure legitimacy and stakeholder support. User-friendly communication tools, such as visual aids, are recommended to make these concepts accessible. While carbon budgeting and GDP adjustments are key for equitable climate adaptation, resistance from industries is expected due to increased scrutiny and potential financial impacts.

(2) Assessment of Conflict Potentials:

Energy Poverty & Community: Conflicts mainly arise from financial and legal challenges linked to energy redistribution. Progressive tariffs and Renewable Energy Communities disrupt established power structures, leading to resistance from traditional energy companies. Legal frameworks must balance these

tensions to ensure equitable energy access. Key conflict areas are distribution, legal, and climate, highlighting the need for inclusive policies.

GHG Emissions & Education: Conflicts are moderate, focused on financing energy-efficient renovations. While educational support for energy efficiency is strong, affordability, especially for low-income communities, remains a concern. Key conflict areas are distribution, legal, and recognition, emphasizing the need to protect marginalized groups.

Job Satisfaction & Education: Conflicts center on restructuring education and training to include sustainability and CSR topics, with resistance anticipated from businesses due to increased regulatory demands. These programs are crucial for long-term workforce development and job satisfaction. Main conflict areas are distribution and legal frameworks, especially around funding.

GDP & Transparency: Major conflicts involve incorporating carbon budgeting and environmental costs into GDP metrics, with business concerns over fairness. Legal challenges in reflecting true environmental and health costs were significant. However, transparency on purchasing power and labor income share in GDP received broad support for its holistic view of economic well-being.

iSDG-AT results

First adjustments of iSDG-AT based on CLDs developed in M1a (M4b)

After processing the CLDs from Workshop 1, the elicited stakeholders' systems understanding was compared to the systems structures of the iSDG-AT model. The iSDG-AT model can be applied to assess policies and pathways to achieve the SDGs considering the complex relationships and interconnections within goals as well as between goals (Allen et al., 2016; Breuer et al., 2019). The iSDG-AT model is a macro-economic, national simulation model based on system dynamics. More detailed information is available in *Working Paper 4b* (Wretschitsch et al., 2024a).

Due to the quantitative nature of the iSDG-AT model, multiple loops that have been central to the stakeholders are not considered within the iSDG-AT model. However, model adjustments have been made on different levels: First, at the structural level a module for the buildings sector has been added to the model to capture the dynamics of e.g. increasing the renovation rate in the buildings sector. This was part of the CLD on greenhouse gas emissions in the buildings sector resulting from WP1 (see Wretschitsch et al., 2024b) and also part of the policy measures considered in the scenarios. Second, an indicator for energy poverty has been added to the model which captures the stakeholders' view that energy poverty is mainly influenced by purchasing power. In the model, this has been implemented by adding an indicator for the energy cost relative to the disposable household income[1]. Third, in the CLDs the level of consumption was of

[1] However, as energy consumption is currently not differentiated by household income groups, this indicator only shows the average over all households and gives a rough indication on energy poverty.

great importance to real GDP per capita and greenhouse gas emissions. The iSDG-AT model, however, mostly focuses on the production side. Consumption in the model is derived through household savings. With regard to household savings calibration adjustments were necessary to better capture the dynamics of savings and thereby also consumption.

Integration of targets and indicators to iSDG-AT based on D2 (M4c)

Only some of the indicators identified (see WP2) are applicable to the iSDG-AT model. The iSDG-AT model cannot account for the qualitative indicators proposed and for other indicators the model currently lacks the necessary data and detail (e.g. regarding the work climate index and work-life balance). For some of the indicators proposed, proxies can be used, considering potential caveats. For example, to assess the impact on measures on energy poverty, the mean energy cost relative to disposable income indicator has been implemented as described above. Other indicators, such as real GDP per capita, are well implemented in the model. However, this indicator was not considered as meaningful by some of the survey participants. Still, in the model real GDP is an important driver for many indicators, e.g. GHG emissions or material consumption, and is thus reported.

In summary, the following indicators have been selected to assess the scenario results: Five years average energy cost relative to disposable income and the Gini coefficient for the social sustainability dimension (SDG1/10); unemployment rate and real GDP per capita for economic sustainability (SDG8) and total greenhouse gas (GHG) emissions (SDG13) and domestic material consumption per capita for an ecological perspective.

Simulation of transition pathways with iSDG (M4e)

As a baseline scenario for the period 2020 to 2050 we implemented the WEM ("with existing measures") scenario (Environment Agency Austria, 2023) in the iSDG-AT model to simulate how the indicators are affected assuming that current energy and climate policies do not change in the future. This included the integration of multiple policies into the model, with minor adjustments of the model structure. The list of measures includes, among others, public investment in the expansion of renewable electricity generation capacities, a CO_2 price scenario for the EU-ETS, increases in the annual renovation rate of public and private buildings, and requiring 100% of all new passenger car registrations to be electric starting from 2035.

Based on the results from the third stakeholder workshop, 17 additional measures have been integrated and simulated in the iSDG-AT model[2]. Besides market-based instruments like an eco-social tax reform, also bans, e.g on combustion vehicles, were considered. The individual measures have been grouped thematically and simulated in isolation to identify individual

[2] For a complete list of measures in the baseline and the SDG scenario and details on their implementation in the iSDG-AT refer to Working Paper 4b (Wretschitsch et al., 2024a).

contributions of measures to the indicators but also spillover and synergy effects. The combination of all measures was simulated in an "SDG scenario", which shows the overall effect the policy package on the achievement of the indicators and SDGs compared to the baseline.

Final iSDG-AT model results

The iSDG-AT model results highlight two different pathways which lead to different future states (see also Figure 5): While the baseline scenario is not very ambitious regarding the reduction of GHG emissions, the SDG scenario shows a substantially faster reduction path and, depending on emission sinks, the goal of achieving net zero emissions is likely achieved in 2050. Also, with respect to domestic material consumption both scenarios show a decline, which is more pronounced in the SDG scenario decreasing to nearly 10t per person in 2050. From a social perspective, the policies implemented in the SDG scenario achieve progress on reducing income inequality (Gini coefficient), whereas in the baseline the current level of income inequality is maintained. Moreover, the indicator for change in energy cost relative to disposable income highlights an increase in both scenarios, however, climate policies cause a stronger upward trend in the SDG scenario. After 2040, the level of energy cost relative to disposable income approaches the baseline level again, as emissions are successfully reduced. Regarding the economic indicators, real GDP per capita is slightly increasing in the baseline scenario, but rather constant in the SDG scenario compared to 2020. The unemployment rate in the baseline continues the increasing trend from the past, but in the SDG scenario the level is strongly reduced and ranges around 4%. Overall, the baseline resembles more a continuation of the past trend, whereas the SDG scenario achieves more progress in achieving the SDGs 1/10, 8 and 13, although the vulnerability to energy poverty might be increased due to a higher ratio of energy cost to disposable income.

Decomposing the SDG scenario in different policy groups highlights the dynamics and impact channels that explain the policy results. While real GDP per capita was not perceived as a meaningful indicator by most stakeholders, it is relevant in the model for explaining developments in other indicators. A policy that has the strongest, negative effect on real GDP per capita is the reduction in worktime (i.e. from 40h to 32h per week) with the assumption that labor productivity does not change. However, it decreases the Gini coefficient as labor income increases at the cost of capital income, thus shifting factor renumeration towards lower household income who rely more on labor income than capital income. Other indicators are also influenced by the work-time reduction: First, lower real GDP per capita supports the goal of reducing GHG emissions and domestic material consumption by decreasing final energy consumption and industry's non-energy emissions when industry production is also reduced. Second, energy cost relative to disposable income is affected by (i) lower energy consumption and thus lower energy cost and (ii) by a lower disposable income compared to the baseline. As the latter dominates, the overall effect of this policy measure is to increase

energy cost relative to disposable income which potentially increases the vulnerability of households to energy poverty.

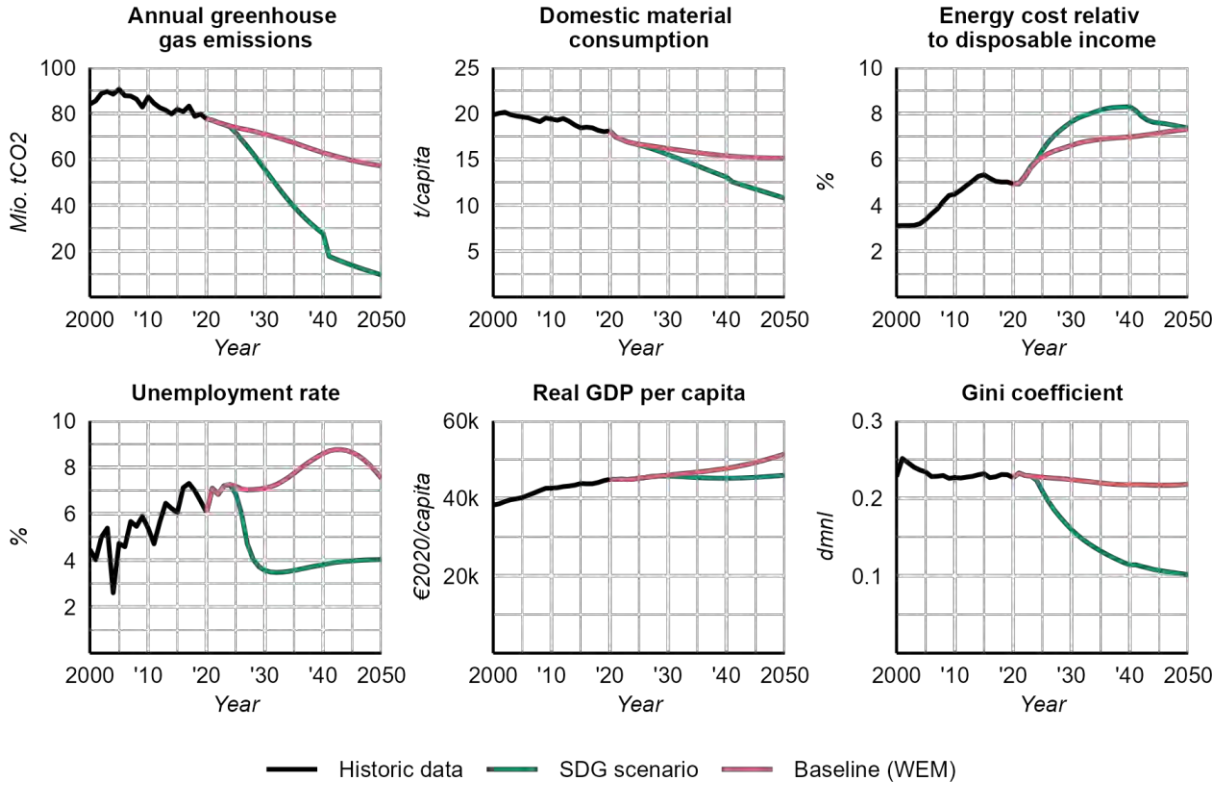


Figure 5: Characterization of the baseline and the SDG scenario based on selected indicators between 2000 to 2050 in the iSDG-AT simulations.

Reductions in GHG emissions are largely attributable to (i) electrification and new technologies, for example, the use of renewable gases in the industry sector, as well as (ii) reduced fossil fuel consumption from electrification and the shift of the model split to less individual motorized transport in the transport sector. After 2040, reaching zero annual GHG emissions relies strongly on the implementation of a ban on the use of all vehicles with combustion engines by 2040. As the consumption of fossil fuel material is also a substantial part of domestic material consumption, these policies also contribute to the reduction of material consumption. Furthermore, investments in circular economy gradually increase the efficiency of metal ores and non-metallic minerals consumption. Finally, the reduction in livestock production causes domestic material consumption to fall due to a decrease in pasture and biomass consumption.

With respect to the energy cost relative to disposable income, policies which intend to increase energy efficiency (e.g. investments in more energy efficient appliances or the buildings' renovation) and to decrease the overall energy consumption (e.g. by redirecting mobility demand from individual motorized transport to public transport) also decrease the average energy cost while replacing fossil fuels with electricity or renewable gases rather pushes the energy cost upwards. A significant upward pressure is also caused by the increase in fossil energy prices due to the eco-social tax reform. Positive synergies unfold as

the CO_2 tax is complemented by other policy interventions that decrease the share of fossil energy in final energy consumption and lower the energy cost. On the other hand, as GHG emissions are greatly reduced, the CO_2 tax loses its effect together with the positive impact on the Gini coefficient, as the tax revenues used for income redistribution diminish. Regarding the Gini coefficient, most spillover effects from other policy interventions do not show significant long-term improvements. The main impact on reducing the Gini coefficient compared to the baseline is only achieved by measures that are explicitly dedicated to redistributing income and increasing lower incomes.

An in-debt analysis of further results and underlying impact mechanisms is provided in *Working Paper 4b* (Wretschitsch et al., 2024a).

WP5 – Stakeholder & expert collaboration and dissemination

Workshops (M5a-c)

For the integration of expert knowledge in this participatory project we selected our stakeholders through personal contacts and prioritized ensuring a balanced representation of the SDGs essential to the project within the group. The further categorization was based on the following criteria: NGO/private, academic context, companies, administration/social partnership institutions. The distribution list was continuously updated, and the number of contact points nearly doubled (from 65 to 108 unique contacts) during the project. The stakeholders were initially contacted personally and subsequently added to the newsletter distribution list and regular updates were provided.

To address the stakeholders' needs, the following materials were provided to stakeholders for each workshop: Manuals (4) explaining the methods used, placing them in a broader context, and including examples for clear understanding; Handouts for the results of the workshop (6); Model descriptions (2) used in the project, which formed the foundation for participatory modelling; Brief summaries of the workshop results; Posters (4); Working papers (5) for each WP; Presentation materials, including slides and posters; Special material for each workshop, i.e. card set for WS2.

The subject of the website is a photograph from the performance *"L'effet Papillon / Mechanical Landscapes"* by Vienna-based artist Christian Ruschitzka, depicting a person rowing on an ice floe. This "happening" took place in 2010 and was deliberately chosen. To further frame the project, the four elements were deliberately chosen as the guiding motif for the cover designs to evoke associative thinking. This conscious choice emphasizes vitality, standing in visual contrast to the objectivity of the UN SDG icons. The elements—water, air, fire, and earth—were thematically assigned to the four workshops in sequence, while sunflower seeds were used for the iSDG data model and meat for IPAM.

Well-prepared materials were provided for each workshop. This seems essential to enable motivated work from the stakeholders. In each workshop, the results of the previous ones were presented, and the method was explicitly and

accessibly explained. As much as possible, the workshops were held in the city center of Vienna. This conscious decision aimed to emphasize the ease of accessibility. For each workshop, specific materials (set-ups) were created for the co-creative process: Workshop 1: Performative spatial setups to inquire how stakeholders assessed synergies and trade-offs; Workshop 2: A card set (The thing from the Future) for associative combinations and collage techniques; Workshop 3: Tablecloths for storytelling, potential/conflict mapping, and the temporal design of paths; Workshop 4: A tablecloth matrix and real-time model simulations on laptops.

This mix of methods still seems well-chosen after reflection, and appropriate for the specific questions at hand in terms of quality, tone, and alignment with the goal of achieving answers. The different qualities of the methods lead to special learning processes in the given situations.

Reflection processes were also integrated within the workshops to allow immediate and direct discussion of the results developed by the stakeholders, and to modify them if necessary. The CoP process was thus a subtle, accompanying aspect of the process. This seemed appropriate in order to minimize influence. Any controversies that arose were given sufficient space.

Identifying impacts, system structure and policy recommendations (M5d)

Milestone M5d addressed the final RO4, i.e.: identification of policy recommendations to achieve the future vision. This included an assessment of measures by stakeholders and recommendations on implementation.

Assessment of measures by stakeholders

The final and fourth stakeholder workshop (WS4) on 04.06.2024 resulted in a co-created recommendation of measures to achieve the future vision and SDGs. Stakeholders were divided into three groups and asked to rank 24 measures (21 from WP3 and 3 additional ones from WP4) on a scale from +3 (strongly positive) to -3 (strongly negative) according to their impact on indicators from WP2. For those measures that could be modelled with iSDG-AT (16) stakeholders were provided with the simulated impact on the indicators real GDP per capita, unemployment rate, GHG emissions, material consumption and share of energy costs in income. Stakeholders were encouraged to suggest additional measures. This led to the inclusion of four additional measures for the assessment by group 2, and to the addition of three additional measures by group 3 in the discussion phase regarding implementation issues (see below – sub-section "Recommendations on implementation by stakeholders").

To not overburden stakeholders with too many assessments, we clustered the indicators along the sustainability dimensions. Hence, each measure was to be ranked three times, once for its ecological impact (GHG emissions, soil sealing, material footprint), economic impact (real GDP/capita, work satisfaction, gender-pay-gap) and social impact (energy poverty, work-life-balance, gender-pay-gap) using the indicators and their target values as anchors for the sustainability

dimension. During a break the research team calculated the total impact as the average of all three impacts, but stakeholders were able to discuss and change the rankings afterwards. This led, in most cases, to significant changes.

Table 1 shows that 14 out of the initially proposed 24 measures were positively evaluated by all of the three stakeholder groups. Institutional measures stand out in particular, such as an improvement in governance (this includes more efficient and transparent administration, but also more active participation in the political decision-making process through e.g. citizens' assemblies), an anchoring of education for sustainable development in as many (further) education curricula as possible, an expansion and qualitative improvement of childcare and the creation of more opportunities for social exchange. These are measures that are often not (or cannot be) considered in quantitative modelling. "Classical" measures, often examined in quantitative model analyses, are mostly assessed positively by the participants, but often not as strongly as might be expected from a modelling perspective (e.g. eco-social tax reform, circular economy, redistribution, energy efficiency, reduction of private transport).

Table 1: Measures that were positively evaluated in all three stakeholder groups.

The minimum impact across all three groups was at least...		
... strongly positive (≥ 2)	... moderately positive (≥ 1 & < 2)	... positive (> 0 & < 1)
1. Improve governance 2. Education for Sustainable Development 3. Expansion of childcare	4. More opportunities for social exchange 5. Promotion of organic agriculture 6. Eco-social guidelines for advertising 7. Reduction of meat consumption 8. Adequate remuneration 9. Promotion of regional production	10. Circular economy 11. Redistribution 12. Energy efficiency of buildings 13. Eco-social tax reform 14. Reduction private transport

Although no measures were rated negatively by all three groups in the overall assessment, there are large differences between the groups, especially for climate mitigation measures (see Table 2) which are often strongly discussed in the current socio-political discourse, such as the electrification of mobility or the decarbonisation of the building and industrial sectors (e.g. Markkanen and Anger-Kraavi, 2019). In group 3, some of these were rated strongly negatively, not only overall, but also for the ecological sustainability dimension. This was

mainly due to the negative effects on other ecological indicators (e.g. resource consumption for electrification) as well as social indicators (e.g. job loss) that the participants suspected. These assessments were not only often at odds with the other groups, but also with the iSDG-AT model simulations, in which the electrification of the mobility sector, the expansion of renewable power generation and the decarbonisation of industry were necessary to achieve the climate targets.

Table 2: Largest differences in the evaluation of measures between the three stakeholder groups

	strongly positive (≥ 2)	moderately positive (≥ 1 & < 2)	positive (> 0 & < 1)
strongly negative (≤ -2)	15. Ban new IC engine trucks 16. Electrification of the mobility sector	17. Ban on IC engine vehicles in stock	
moderately negative (> -2 & ≤ -1)	18. Reduction of working hours	19. Mandatory CO2 budget	
negative (> -1 & < 0)	20. Spatial energy planning	21. Ban on fossil-fuel heating systems 22. Expansion of renewable power 23. Decarbonization of industry	24. Limitation of living space

Recommendations for implementation by stakeholders

After the assessment, stakeholders were given the opportunity to provide recommendations on the actual implementation of the measures and how to overcome implementation barriers. We received, in total, recommendations on 17 measures. Most groups started with those most highly ranked by them. Time constraints made it impossible to provide recommendations on all measures. Examples of recommendations are provided in (Kirchner et al., 2024a, 2024b). Across all measures, systems and cross-generational thinking was often particularly important to the participants: involving as many actors as possible (e.g. citizens' assemblies, seeking discussions), awareness-raising, vertical and horizontal implementation (e.g. circular economy and education for sustainable development at all levels), consideration of all sustainability dimensions (e.g. not only regional, but also social and ecological), and a wish for less social inequality (e.g. progressive design of policies in terms of burden/support for households).

5 Conclusions and Recommendations

Transforming for Sustainability: A Collaborative Effort

Tackling the transformation towards a more socially just and ecologically sustainable society remains a daunting but achievable task. This project has contributed important building blocks to support such a transformation, particularly in advancing the Sustainable Development Goals (SDGs) of climate action (SDG13), no poverty/reduced inequality (SDG1/10), and decent work and economic growth (SDG8). By combining a participatory stakeholder processes with scientific modelling approaches, we were able to identify synergies, trade-offs, and conflicts within and between these SDGs, develop shared visions for a sustainable future, chart pathways to address challenges, and co-create policy recommendations.

A Common Systems Understanding: Key Trade-Offs Identified

Stakeholders highlighted a critical trade-off: greenhouse gas emissions (a central indicator of SDG13) are expected to rise as long as real GDP per capita (SDG8) continues to grow. While economic growth can help alleviate energy poverty (SDG1/10), poorly designed climate mitigation measures risk exacerbating social and ecological inequalities. This highlights the need for integrated policies that consider potential trade-offs and address both environmental and social dimensions simultaneously.

A Shared Future Vision: Considering the Broader Picture

The stakeholder-driven vision emphasized the importance of looking beyond isolated SDGs to consider the broader sustainability picture. While disagreements arose regarding specific indicators, such as the target value of real GDP per capita, there was consensus on achieving a future where all dimensions of sustainability flourish. This shared vision underscores the need for holistic, systems-thinking approaches that account for the interconnections between SDGs.

Pathway Narratives: Focus on "Atypical" Measures

Stakeholder-proposed measures often diverged significantly from those traditionally emphasized in quantitative modelling approaches. Institutional reforms (e.g., improved governance, education for sustainable development, eco-social guidelines for advertising), regulatory changes (e.g., expansion of childcare, adequate remuneration, redistribution), and behavioral shifts (e.g., sufficiency practices, reduced meat consumption) were prioritized over economic instruments like pricing or subsidies. Stakeholders evaluated these measures as being more impactful for achieving the shared vision. Quantitative modelling and

qualitative expert assessments largely validated the positive potential of these measures.

Combining Knowledge Integration Processes: Bridging Blind Spots

While stakeholder recommendations often included innovative, high-leverage measures, they sometimes lacked technical feasibility or sufficient detail to address key challenges like climate targets. Although models may miss such "atypical" measures, they in turn revealed black spots in stakeholders' recommendations, such as additional measures needed to achieve climate targets (e.g., decarbonization of industry, electrification of mobility) due to the application of iSDG-AT, and additional measures needed to reduce the trade-off between climate action and energy poverty (e.g., energy literacy initiatives, progressive energy tariffs, and community-focused programs) due to the application of IPAM expert interviews.

This project thus underscored the critical role of stakeholder insights in shaping transformative policies. Stakeholder contributions highlighted innovative measures that might otherwise have been overlooked, while scientific methods provided a necessary reality check to ensure feasibility and coherence. By integrating these perspectives, we were able to develop more comprehensive and actionable recommendations.

Leverage Points for a Sustainable Transformation

Quantitative modelling approaches usually focus on policy measures that would rank low in the leverage point hierarchy (Abson et al., 2014; Dorninger et al., 2020; Meadows, 1997), which categorizes interventions by their potential to bring far-reaching change to a system. Quantitative models typically focus on parameter changes such as prices, subsidies or regulations that have usually low leverage potential. Some of the measures proposed and positively evaluated by the stakeholders rank much higher in this hierarchy and can be labelled as "deep leverage points" (as opposed to "shallow leverage points"): First, the measures *improvement of governance*, *increased opportunities for social exchange* and *using media channels intelligently* could affect the design of the system by changing the social structures and institutions that manage and govern this system (e.g. by changing the structure of information flows, the rules of the system and the system structure itself). Second, even more impactful are measures that aim to change values and goals, such as *education for sustainability* and *sufficiency*. A focus away from material life standards and a better appreciation of ecological limits and social justice could trigger fundamental changes in our current system. This does not mean that shallow leverage points are not needed or not impactful, but it indicates that measures at a lower level of the leverage point hierarchy need to be supported by measures

that trigger social tipping points (Otto et al., 2020; Winkelmann et al., 2022) in order to make the transformation itself sustainable.

Stakeholder Recommendations for Implementation

Stakeholders emphasized the importance of systems and cross-generational thinking. This means, among other things, involving as many actors as possible (e.g. citizens' assemblies, seeking discussions), awareness-raising, vertical and horizontal implementation (e.g. circular economy and education for sustainable development at all levels), consideration of all sustainability dimensions (e.g. not only regional, but also social and ecological), and a wish for less social inequality (e.g. progressive design of policies in terms of burden/support for households).

Final Reflections and Future Directions

Our research demonstrates that achieving sustainable development is not just a technical or economic challenge but a deeply social one, requiring shifts in cultural and institutional practices, valuing education, transparency, and good governance. Valuing stakeholder contributions alongside scientific rigor offers a pathway to creating robust, inclusive, and adaptive policies. We encourage further engagement with participatory, holistic approaches that integrate diverse knowledge systems to address the complexities of sustainability transitions. Proactively addressing identified conflicts and synergies will be crucial for achieving a just and sustainable future.

C) Projektdetails

6 Methods

Overall methodological approach

As outlined in Section 3 (*Background and Objectives*), our project aimed to integrate participatory knowledge processes with both quantitative and qualitative modeling methods. Unlike many modeling-based research projects with stakeholder involvement, we prioritized a *transdisciplinary perspective* (Hirsch Hadorn et al., 2010), placing participatory approaches at the forefront and using modeling as a supportive tool. This stakeholder-first approach fosters a comprehensive, inclusive understanding of the system, enabling the identification of critical intervention points that drive transformative change, rather than merely adjusting individual parameters (van Dijk et al., 2023). By actively engaging stakeholders, we enhance the inclusivity, credibility, and local relevance of the research outcomes (Dendena and Corsi, 2015). Our methodologies are further grounded in *Systems Thinking*, which provides a robust framework for understanding and analyzing complex systems (Meadows, 1997; Sterman, 2000). The methods applied include:

- Community of Practice (*Palmetshofer et al., 2024*),
- Causal Loop Diagrams (CLDs) (*Wretschitsch et al., 2024b*),
- Arts-based methods (*Hinterberger et al., 2024b*),
- Storytelling and backcasting (*Bukowski et al., 2024b*),
- IPAM modeling (*Bukowski et al., 2024a, 2024b*), and
- iSDG-AT modeling (*Wretschitsch et al., 2024a*).

Notably, *Working Paper 5*, structured as a *working tableau*, visually chronicles the methodological approach and progression of the project (Palmetshofer et al., 2024). This tableau highlights the integration of participatory processes with systems-oriented modeling, providing a clear narrative of the project's evolution and its commitment to transformative, stakeholder-driven research.

Communities of Practice

Background

Wenger (1999) defines Community of Practice (CoP) "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly." Translating this to our research project means that we aimed to create a place where both researchers and stakeholders can learn more about the challenges of achieving the SDGs while also identifying solutions

for bringing as forward. Wenger (1999) further emphasizes the importance of three characteristics:

The domain: A shared area of interest that gives the community its identity. Members are committed to the domain and build expertise collectively.

The community: Relationships and interactions among members foster collaboration, knowledge-sharing, and mutual learning.

The practice: Members develop and refine a set of shared practices, including experiences, stories, tools, and approaches, which evolve over time through sustained engagement.

Applications

To foster stakeholder commitment, active participation, and effective knowledge exchange, we implemented a variety of activities and tasks tailored to enhance:

1. Commitment to the project and its objectives (the domain)
2. Stakeholder interactions and participation (the community)
3. Knowledge integration and exchange (the practice)

This multi-faceted approach combined creative design elements, robust communication strategies, and innovative facilitation methods to maximize stakeholder involvement and ensure the project's relevance and impact:

1. Establishing a Cohesive Project Design

Developed a unified design theme across project materials using the four elements—water, air, fire, and earth—as a guiding motif. These elements symbolized vitality and creativity, contrasting with the objectivity of the UN SDG icons. They were sequentially assigned to the workshops, while sunflower seeds represented the iSDG model and meat symbolized IPAM.

2. Stakeholder Mapping, Engagement & Communication

Created and maintained a stakeholder matrix and a contact list of relevant experts and interested parties. Established a unique project email address for direct communication. Distributed newsletters to keep stakeholders informed.

3. Bilingual Project Website

Launched and managed a website (https://sdg.visionpath.at/) in German and English. The website featured artistic visuals, including a photograph from the performance *L'effet Papillon / Mechanical Landscapes* by Christian Ruschitzka, depicting a person rowing on an ice floe.

4. Facilitating Workshops, Webinars, and Informal Meetings

Delivered well-prepared materials to ensure stakeholders could engage effectively. Each workshop built on prior results, with clear and accessible explanations of the methods. Workshops were held in central Vienna to ensure easy accessibility. Workshop-specific creative tools included: Performative spatial

setups for synergy and trade-off assessments (Workshop 1); A card set (*The Thing from the Future*) for associative combinations and collage techniques (Workshop 2); tablecloths for storytelling, conflict mapping, and temporal path design (Workshop 3); tablecloth matrices and real-time model simulations on laptops (Workshop 4).

5. Stakeholder-Friendly Documentation

Created handouts, manuals, and summaries that explained methods and summarized workshop results. Shared results as stakeholder-friendly handouts (*Handreichung*), disseminated via email, and published on the project website.

6. Dissemination of Research Findings

Presented preliminary findings and working papers at national and international conferences, fostering further discussion and engagement.

Participatory system mapping & Causal Loop Diagrams (CLDs)

Background

One tool that is well suited for participatory expert and stakeholder engagement is that of Causal Loop Diagrams (CLDs) (Olivar-Tost et al., 2020), especially in comparison to other methods available for analyzing SDG interactions (Horvath et al., 2022). It is well suited for extracting knowledge on systems' dynamics from experts. Due to time and resource constraints, only a subset of indicators that are relevant to the broader topic of each SDG and at the same time are dynamically linked, could be investigated in this process. The selected indicators for which the dynamic structures were elaborated with stakeholders were: i) Energy poverty (SDG1/10); ii) Real GDP per capita (SDG8); iii) Work satisfaction (SDG8); iv) Greenhouse gas emissions (SDG13); and v) Greenhouse gas emissions for the building sector (SDG13). Although these are not explicit SDG indicators, we decided to take advantage of the vagueness of the SDGs that leaves room for interpretation and manoeuvre in stakeholder processes (Saiz and Donald, 2017b, p. 1031). Dynamics relevant to all five of these indicators and thereby the four selected SDGs were elicited with stakeholders. For a detailed description of the mapping process see the next section.

Application

The CLD method was applied in the first workshop (co-create a common systems understanding). The participatory modeling process included several key steps:

Preparation of Indicators: Five SDG-linked indicators were preselected (e.g., energy poverty, GDP per capita, work satisfaction, GHG emissions) based on researcher expertise and data availability. Handouts were prepared for discussions, with translations provided in annexes.

Trial Workshop: A preliminary workshop with students and colleagues tested methods, agenda, and facilitation techniques, refining the final workshop script and strategies.

Survey on Variables: An online survey gathered over 20 drivers per indicator (143 total), which were formatted for causal loop diagram (CLD) use. These variables were printed for the workshop.

Stakeholder Workshop: Stakeholders reviewed, added, and clustered variables, identified linkages, and worked collaboratively on CLDs. Insights were presented, and connections between CLDs were explored, followed by group discussions and feedback.

Post-Processing Results: The research team digitized and refined the CLDs, identifying feedback loops, synergies, and trade-offs. Individual CLDs were merged into an overarching model. Results were shared via a webinar, handouts, and the project website.

Arts-based methods

Background

The integration of arts-based methods in the transdisciplinary research process builds on the fact that sustainability issues require diverse perspectives across varied disciplines and sectors. This approach implies that different types of knowledge and ways of knowing are considered as integral part of the research design and process (Hadorn et al., 2008; Hoffmann et al., 2017; Vilsmaier et al., 2017). The arts allow participants to express their emotional level and activate sensory experiences to create a more holistic understanding of complex issues (Heinrichs, 2018; Kagan, 2015). Further, arts-based methods are most valuable when deployed for research processes that require participants to "(…) explore, describe, evoke, provoke or unsettle." (Leavy, 2017, p. 191). This in turn shows that arts-based approaches are specifically suited to deal with ambiguity, contradictions and complexity (Kagan, 2015).

The arts-based methods applied in this project follow the theory of speculative design (Dunne and Raby, 2013). This approach utilizes design as a critically scrutinising medium and practice that explores the effects of new developments and utilizes design as a catalyst for alternative social spaces of imagination. The method makes it possible to develop and discuss completely freely imagined scenarios and more fact-based ideas of the future side by side. Another key aspect of speculative thinking is detaching from the hierarchy of knowledge forms like data, information, and knowledge (see Boulding, 1955).

Applications

Arts-based methods were applied in the second workshop (co-creating future visions). To familiarize the participants with speculative thinking, examples from speculative design were presented at the beginning. After this introduction three

arts-based methods were applied: (1) The game "The Thing from the Future" and (2) a Futures Panel with (3) Collage used as a tool for knowledge production.

Game "Thing from the Future"

The team adapted the open-source card game *The Thing from the Future*[3] for the workshop, aligning it with the objectives and context. The game prompts participants to design fictional future objects within specific categories, kick-starting speculative thinking. This approach encourages imagining and shaping the future in the present. For the workshop, new categories were created based on key topics from the first session, such as growth and distributive justice. Players explored these themes in speculative contexts, inventing "things from the future" based on fictional scenarios. Each three-minute round prioritized rapid idea generation over feasibility, with participants sharing and discussing their ideas after each round. The activity concluded after three rounds, with all results collected. This playful method was designed to "open up" participants' thinking, fostering a bold and experimental mindset for envisioning future possibilities in the subsequent steps.

Futures Panel & Collage as Knowledge Production

The *Futures Panel* was designed to unify diverse participants around a shared framework—a hypothetical transdisciplinary experts panel established by a future Austrian federal government. The panel aimed to develop innovative visions based on status-quo scenarios.

Participants presented their visions as a fictional newspaper supplement for a major national publication in 2050. This format allowed for a coherent presentation of multiple topics while requiring participants to condense and collaboratively refine their visions into a communicable format. The process demanded significant negotiation skills, as participants reconciled differing perspectives on the future.

A collage method was used to create the supplement, combining text and image elements quickly to form a cohesive whole. This approach encouraged experimentation, integrating conscious decisions with the element of chance. Collaging facilitated essential cognitive and sensory processes of knowledge production, including research, selection, and reassembly of elements to create new connections (Hopf, 2021).

This method effectively guided participants between the realms of the realistic and the impossible, fostering a productive approach to uncertainty and opening a broad space for creative possibilities. By designing their vision in a tangible newspaper format, participants were supported in concretizing and communicating their ideas.

[3] see https://situationlab.org

Storytelling

Background

Storytelling has become a valuable tool in science, enabling researchers, often in collaboration with artists, to communicate complex content in engaging and accessible ways. It plays a growing role in bridging the gap between science and society, particularly for SDG-related concepts, by placing ideas in narratives that foster identification and emotional engagement (Fischer et al., 2020). Stories enhance memory retention and make difficult topics more relatable by combining facts with narrative elements (Green, 2021; Gupta and Jha, 2022). For instance, case studies in teaching have shown improved understanding and engagement when content is presented as a story (Yin, 2009).

To be impactful, scientific findings must be woven into narratives that engage stakeholders throughout the research process, from development to external communication. Stories help illustrate the relevance of research, motivate participation, and reach diverse stakeholder groups, which is essential for co-creative projects (Joubert et al., 2019).

An example is the *Citizen Science* approach, where storytelling highlights the real-life benefits of research, encouraging broader engagement (Hecker et al., 2018). However, storytelling in science poses challenges, such as the risk of oversimplification or loss of crucial details (Avraamidou and Osborne, 2009). Balancing narrative vividness with scientific accuracy requires careful triangulation of artistic and scientific methods, as practiced in this research project.

Application

In the third workshop, storytelling was used to explore transformation pathways, drawing on Robert Jungk's *Future Workshops* method (Jungk and Müllert, 1997). The process began with revisiting goals from the second workshop, such as: *"Citizens' councils have the power to decide on trend-setting measures, provided they have adequate education."*

Participants identified potential obstacles to these goals, such as legal conflicts, insufficient participation mechanisms, or inadequate citizen education, noting their ideas on cards. These problems were then reframed into solutions through a future-oriented perspective (*"Future II: How will we have achieved our goals?"*). For instance, the challenge of insufficient mechanisms was reimagined as: *"Education, science, policy, and civil society collaborate to integrate citizens' councils as decision-makers by expanding participation and enacting relevant laws."*

Finally, visionary goals were linked to actionable strategies, with stakeholders defining measures and instruments to address environmental and social impacts through participatory modeling.

Backcasting

Background

Backcasting, a strategic planning tool, starts with a desirable future and identifies steps to achieve it (Robinson, 1990). Unlike forecasting, backcasting fosters transformative change by envisioning normative outcomes, such as low-carbon economies or equitable societies, through systems thinking and multi-level perspectives (Geels, 2002; Meadows, 2008). Artistic methods enhance backcasting by fostering creativity and stakeholder engagement, though concerns about their practicality persist (Quist and Vergragt, 2006). Key approaches in backcasting include:

1. Scandinavian Backcasting: Emphasizing participatory planning, this iterative process engages stakeholders in visioning and scenario formulation (Dreborg, 1996).
2. Sustainable Transitions Framework: Combines socio-technical transition insights with backcasting to align technological and institutional innovations (Geels, 2002).
3. Integrated Assessment Models (IAMs): These models quantify the feasibility of pathways, aiding policymakers in designing sustainable futures (van Vuuren et al., 2011).

Application

Backcasting was applied at the end of the third workshop (co-creating transformation pathways). Measures and instruments identified and evaluated in the previous steps were placed in a chronological period up to 2050 and put in a causal relationship in the final and third step. The individual pathways were also organized according to the thematic blocks of this workshop, i.e. community pathway, education pathway, transparency pathway. The paths were processed ex-post by the scientific project team: On the one hand, similar measures were bundled together and clustered if they were close in time. Secondly, the measures were also assigned to the SDGs and their indicators from the first workshop, i.e.: SDG1&10 with energy poverty ('A|U'); SDG8 with job satisfaction ('AZ') and real GDP per capita ('GDP') and SDG13 with greenhouse gas emissions - 'GHG'). The result is a comprehensive picture of many individual paths, which are described in more detail in the result section.

IPAM

Background

The Inequality and Poverty Assessment (IPAM) model was applied to conduct a kind of Environmental and (Social) Impact Assessments (ESIA) in model form through the framework of distribution, community (participation), legitimacy, recognition, and fair climate and environmental adaptation. This can highlight

potential conflicts and challenges associated with implementing policy options, offering insights into the complexities of achieving Sustainable Development Goals. Designed and applied to analyze SDG-related issues of concern, the IPAM follows a multidimensional approach (Bukowski and Kreissl, 2022) that is based on a previous design of a Conservation Justice and Conflict Modell (CJC) (Bukowski, 2019, 2018), with the emphasis on five recurring justice dimensions mentioned in the relevant scientific literature to reduce poverty and inequality (Nussbaum, 2011; Sen, 2009). Using different methods from a qualitative content analysis (supported by a computerized comparative data analysis), stakeholder integration and literature review, it has narrowed down the vast quantity of scientific publications, and filtered the most frequently appearing and most agreed upon dimensions that are relevant for inequality and poverty (Nussbaumer et al., 2013). Additionally, the indicator sets include environmental management and governance research (Madden and McQuinn, 2014; Redpath et al., 2015), which play a key role in the theoretical framework of this model and serve as guidance and foundation for the development of the analysis framework. These indicators are partly derived from Ostrom's et al. 'design principles' for a sustainable resource management that lowers social conflict potentials (Ostrom, 1990; Sen, 2009). The triangulation of different justice theories and approaches allows a closer examination of socio-environmental and economic problems and inequality potentials, with regards to SDG action implementation and institutional performance (Schlosberg, 2007).

Applications

IPAM was applied twice in the project. First, as part of the third workshop (co-creating transformation pathways) and second, as part of an overall evaluation regarding the measures proposed and recommended by the stakeholders in third and final workshop, respectively.

Third workshop

In the third workshop, IPAM was adapted to facilitate the co-creative development of implementation ideas—specifically measures and instruments—aimed at refining pathways and steps for future implementation. Participants were asked to discuss and evaluate measures identified in the storytelling exercise based on specified dimensions and categories, focusing on relevant themes (e.g., transparency, community, education). Throughout this process, additional measures were identified. At the conclusion, participants allocated a total of 15 points among the dimensions they believed required special attention, indicating areas that were particularly challenging or had significant potential for conflict or improvement. This qualitative scoring provided a way to prioritize challenges and visually represent the assessment within the IPAM.

Expert evaluation of measures proposed and recommended

For the final expert evaluation, IPAM organized the central topics from the project proposal and WP1, aligning them with specific SDGs. These include

Energy Poverty (SDG1), GHG Emissions (SDG13), GDP and Job Satisfaction (SDG8), as well as newly introduced dimensions such as Transparency (SDG16), Education (SDG4), and Community (SDG11/SDG10), as derived in the second workshop. To ensure operational clarity and facilitate context-specific policy development, these thematic areas were grouped into four clusters: (1) Energy Poverty & Community; (2) GHG Emissions & Education; (3) Job Satisfaction & Education; (4) GDP & Transparency.

These clusters, together with the dimensions and categories of the IPAM framework, guided the expert evaluation of the measures developed in WP3. The evaluation process had two primary objectives: (a) to validate the findings from the workshops, and (b) to propose additional measures. Experts were selected through a stakeholder analysis, ensuring representation from four key groups: (1) Government institutions (at both state and federal levels); (2) Businesses (including production, energy, and construction sectors); (3) Non-governmental organizations (NGOs), particularly those focused on social issues such as Caritas, Diakonie, and the Poverty Conference; (4) Academics and researchers (including the UniNEtZ initiative).

This comprehensive stakeholder engagement process ensures that the evaluation and recommendations are grounded in a diverse range of expertise, providing a robust basis for policy formulation and sustainable development strategies. In total, 17 representatives from these groups participated in the IPAM expert interviews, each lasting about 45 minutes. To evaluate the five IPAM dimensions, each expert was given 9 points to distribute according to the socio-ecological conflict potential within each category. In total, 153 points were allocated. The results (see Figure 2) show that both experts and workshop participants identified "Distribution" (distributive justice) as the IPAM dimension with the highest conflict potential (46 points).

iSDG-AT

Background

This project employed a system dynamics-based computational modelling approach, which enables the analysis of multiple interaction effects and the dynamic evaluation of synergies arising from the combination of different policies to achieve multiple goals simultaneously(Allen et al., 2016; Pedercini et al., 2020). The iSDG-AT model was applied to assess policies and pathways to achieve the SDGs considering the complex relationships and interconnections within as well as between goals (Allen et al., 2016; Breuer et al., 2019). The iSDG-AT model is a macro-economic, national simulation model based on system dynamics. The iSDG model and its predecessor, the Threshold21 model, have been applied to various country contexts for analyses of national development pathways and pathways to achieve the SDGs (Allen et al., 2024; Li et al., 2024; Pedercini et al., 2018b).

The model encompasses 30 sectors that represent economic (e.g. the production of different industry, services and agricultural sectors), social (e.g. population) and environmental (e.g. energy consumption and production) dynamics. Thereby, the model covers a broad range of elements relevant to targets and indicators of the SDGs. Each does not only capture the underlying structure of the individual sector but is also linked to other sectors. Specifically, the latter is crucial to analyse synergy potentials among different goals. A more detailed description of the model sectors and variables is provided in the model documentation (Millennium Institute, 2021) or in Allen et al. (2019b).

The iSDG-AT model integrates key sectors and indicators to capture interactions among SDG1/10, SDG8, and SDG13, including household income, inequality (Gini coefficient), economic production, employment, energy use, and GHG emissions. Unique to this model is a governance sector that evaluates aspects like corruption and government effectiveness, enabling the analysis of governance impacts, such as increased productivity, lower infrastructure costs, and more effective policies. Enhancements based on this research include a buildings sector to address GHG emissions, renovation policies, and energy efficiency, alongside new structures for renewable electricity expansion and private investment in industry transformation. Additionally, an "average energy cost relative to disposable income" indicator was added to address energy poverty, reflecting stakeholder insights.

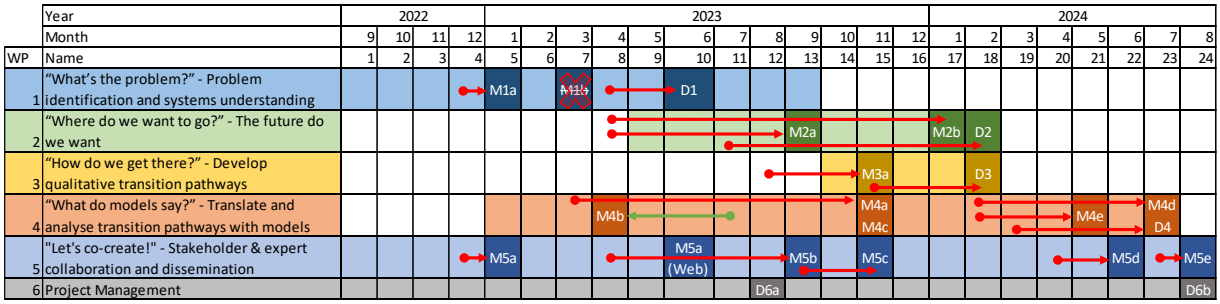
Application

Two scenarios are simulated using the iSDG-AT model (Spittler and Kirchner, 2022), which was developed based on the core iSDG model established by the Millennium Institute (Allen et al., 2019b; Millennium Institute, 2021). The baseline scenario reflects the impact of Austria's climate and energy policies as of early 2022 on the SDGs (Environment Agency Austria, 2023). The second scenario, the "SDG scenario," incorporates a set of policy interventions designed in a participatory stakeholder process within the *SDGVisionPath* project. These interventions aim to address not only climate goals but also social inequality and work satisfaction.

7 Work and timeplan

Table 3 shows the GANTT diagram for our project. Red arrows indicate delays in the achievement of milestones, green arrows indicate when milestones have been achieved earlier. The dot at the other end of the arrow indicates the originally planned date. The red and transparent "X" indicates that milestone M1b was cancelled. Despite some delays we were able to finish the project within the proposed deadline.

Table 3: GANTT diagram for SDGVisionPath



List of milestones and deliverables

M1a	A first common systems and problem understanding is established	M4d	Validation and evaluation of transition pathways by IPAM
M1b	Recheck & validation of system and problem understanding with IPAM finished	M4e	Simulation of transition pathways with iSDG
D1	Translation of common systems and problem understanding for WP2	D4	Final model results available
M2a	A common future vision for achieving SDGs 8, 10 and 13 is created	M5a	Workshop on systems and problem understanding (-> M1a)
M2b	Targets and indicators to measure progress are identified	M5a(Web)	Follow-Up Webinar on M1a
D2	Translation of indicators and goals to the SDG context	M5b	Workshop on future vision (-> M2a, M2b)
M3a	Storylines for qualitative transformation pathways are created	M5c	Workshop on transition pathways (-> M3a)
D3	Translation of pathways to model contexts	M5d	Workshop on policy recommendations
M4a	First application of IPAM conducted (M1b)	M5e	Dissemination focus
M4b	First adjustments of iSDG based on CLDs developed in M1a	D6a	Interim project report
M4c	Integration of targets and indicators to iSDG based on D2	D6b	Final project report

8 Publications and Dissemination activities

8.1 Dissemination aimed at stakeholders and the general public / policy makers

Visual identity and design

A visual concept was made, representing overlapping fields of research questions as well as using images of artworks from Austria which relate to the topics in a specific manner. Furthermore, the visual concept of using textural images of elements of the earth (water, air, fire, earth) and an image database were created. Additionally, a project internal short guide for using the brand of the project was created (half-one pager).

Stakeholder friendly handouts **("Handreichungen")**

We designed and developed stakeholder friendly material ("Handreichungen") regarding the results and methods of the stakeholder workshops, the surveys as well as the scientific modelling methods. The material provided included a manual for each method used in the workshops, the workshop results, the description of the models used and brief summaries for the workshops. Those materials were published on the website in German and English and were distributed via email/newsletter to the stakeholders. In total, we created 16 stakeholder friendly handouts:

Workshop 1:

1. *Handout WS1-1:* Kirchner, M., Spittler, N., Wretschitsch, E., Gerdes, D., Bukowski, M., Hinterberger, F., Palmetshofer, G., 2023. Was ist das Problem? Ergebnisse des ersten SDGVisionPath Workshops. SDGVisionPath Handreichung No. W1-1. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/01_Ergebnisse.pdf
2. *Handout WS1-1short:* Kirchner, M., Spittler, N., Wretschitsch, E., Gerdes, D., Bukowski, M., Hinterberger, F., Palmetshofer, G., 2023. Was ist das Problem? Ergebnisse des ersten SDGVisionPath Workshops - Kurzfassung. SDGVisionPath Handreichung No. W1-1short. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/01_Ergebnisse_Kurzfassung.pdf
3. *Handout WS1-2:* Kirchner, M., Spittler, N., Wretschitsch, E., Bukowski, M., Hinterberger, F., Palmetshofer, G., 2023. Ein SDG-übergreifendes Systembild: Synergien & Trade-Offs. SDGVisionPath Handreichung No. WS1-2. BOKU University, Paris Lodron Universität Salzburg, die

Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/01_CLD_Gesamtbild.pdf

4. *Handout WS1-3:* Kirchner, M., Spittler, N., Wretschitsch, E., Gerdes, D., Bukowski, M., Hinterberger, F., Palmetshofer, G., 2023. Systemdynamische Wirkungsdiagramme - Causal Loop Diagramme (CLD). SDGVisionPath Handreichung No. WS1-3. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/01_Manual_CLDs.pdf

Workshop 2:

5. *Handout WS2-1:* Hinterberger, F., Payerhofer, U., Muhr, M., Janu, R., Bukowski, M., Kirchner, M., Palmetshofer, G., 2023. Wohin wollen wir gehen? Ergebnisse des zweiten Workshops. *SDGVisionPath Handreichung No. WS2-1*. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/02_Ergebnisse.pdf

6. *Handout WS2-1short:* Hinterberger, F., Payerhofer, U., Muhr, M., Janu, R., Bukowski, M., Kirchner, M., Palmetshofer, G., 2023. Wohin wollen wir gehen? Ergebnisse des zweiten Workshops. SDGVisionPath Handreichung No. WS2-1short. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/02_Ergebnisse_Kurzfassung.pdf

7. *Handout WS2-2:* Hinterberger, F., Payerhofer, U., Muhr, M., Janu, R., Bukowski, M., Kirchner, M., Palmetshofer, G., 2023. Spekulatives Denken und Spekulative Settings. SDGVisionPath Handreichung No. WS2-2. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/02_Manual_Spekulativ.pdf

8. *Handout WS2-3:* Hinterberger, F., Bukowski, M., Fingerlos, I., Kirchner, M., Palmetshofer, G., 2024. Die Erreichung der Ziele messen. SDGVisionPath Handreichung No. WS2-3. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/02_Ergebnisse_Manual_Indikatoren.pdf

Workshop 3:

9. *Handout WS3-1:* Hinterberger, F., Bukowski, M., Kirchner, M., Palmetshofer, G., 2024. Wie kommen wir dahin? Ergebnisse des dritten Workshops. SDGVisionPath Handreichung No. WS3-1. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa

Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/03_Ergebnisse.pdf

10. *Handout WS3-1short:* Hinterberger, F., Bukowski, M., Kirchner, M., Palmetshofer, G., 2024. Wie kommen wir dahin? Ergebnisse des dritten Workshops - Kurzfassung. SDGVisionPath Handreichung No. WS3-1short. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/03_Ergebnisse_Kurzfassung.pdf
11. *Handout WS3-2:* Hinterberger, F., Bukowski, M., Kirchner, M., Palmetshofer, G., 2024. Storytelling. SDGVisionPath Handreichung No. WS3-2. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/03_Manual_Storytelling.pdf

Workshop 4:

12. *Handout WS4-1:* Kirchner, M., Spittler, N., Wretschitsch, E., Bukowski, M., Hinterberger, F., Palmetshofer, G., 2024. Was können wir empfehlen? Ergebnisse des vierten und letzten Workshops. SDGVisionPath Handreichung No. WS4-1. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/04_Ergebnisse.pdf
13. *Handout WS4-2:* Kirchner, M., Spittler, N., Wretschitsch, E., Bukowski, M., Hinterberger, F., Palmetshofer, G., 2024. Was können wir empfehlen? Ergebnisse des vierten und letzten Workshops – Details der Vorschläge. SDGVisionPath Handreichung No. WS4-2. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/04_Ergebnisse_Details.pdf

Models:

14. *Handout M1-1:* Bukowski, M., Palmetshofer, G., 2023. IPAM Modellbeschreibung. SDGVisionPath Handreichung No. M1-1. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/M_IPAM.pdf
15. *Handout M1-2:* Wretschitsch, E., Spittler, N., Kirchner, M., Palmetshofer, G., 2023. iSDG Modellbeschreibung. SDGVisionPath Handreichung No. M1-2. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien. https://sdg.visionpath.at/wp-content/uploads/M_ISDG.pdf
16. *Handout M1-3:* Palmetshofer, G., Wretschitsch, E., Bukowski, M., Spittler, N., Kirchner, M., 2023. Modellbeschreibungen Kurzfassung.

SDGVisionPath Handreichung No. M1-3. BOKU University, Paris Lodron Universität Salzburg, die Angewandte, cooppa Mediengenossenschaft eG, Wien.
https://sdg.visionpath.at/wp-content/uploads/00_Modelle_Kurzfassung.pdf

Project website and social media

The website https://sdg.visionpath.at/ was set up at the very beginning of the project and provided up-to-date information on the project. This included news post of activities and up-coming events, such as stakeholder workshops. 57 posts have been made at the German website. Both Fritz Hinterberger and Mathias Kirchner used their Twitter/X accounts to occasionally disseminate information regarding SDGVisionPath.

Project newsletter

For communication with the stakeholders a newsletter system (brevo) was installed. In this feature we used only email-campaigns. 19 newsletters have been sent out. The average opening-rate was 51%, the average clickthrough rate was 32%, and bounces and block rate 3%.

8.2 Scientific publications and disseminations

Journal publications and other manuscripts

- Hinterberger, F., 2025. How to achieve a wellbeing economy from macro to micro, in: Mühlbock, M. (Ed.), Sustainable Transformation and Well-Being. Springer Cham. https://link.springer.com/book/9783031755651
- Bukowski, M., Fingerlos, I., 2025. Arm trotz Arbeit, in: Auer-Mayer, S., Stöckl, E., Gmainer-Pranzl, F. (Eds.), Prekäre Arbeit. Neue Herausforderungen Für Gesellschaft Und Wissenschaft. Peter Lang Verlag, Austria. (the collection volume has been successfully reviewed and is in the publication process 2025).

Working Papers submitted as pre-prints to https://www.ssrn.com/ and to be submitted to peer-reviewed SSCI-listed journals soon

- *Working Paper No. 1:* Wretschitsch, E., Spittler, N., Palmetshofer, G., Bukowski, M., Hinterberger, F., Kirchner, M., 2024b. Making stakeholder knowledge on SDG interaction explicit − a Causal Loop Diagram (CLD) approach. https://sdg.visionpath.at/wp-content/uploads/SDGVisionPath_WP1.pdf
- *Working Paper No. 4a:* Bukowski, M., Hinterberger, F., Kirchner, M., 2024. Insights from a participative Inequality and Poverty Assessment Modelling process (IPAM). https://sdg.visionpath.at/wp-content/uploads/SDGVisionPath_WP4a.pdf

- *Working Paper No. 4b*: Wretschitsch, E., Spittler, N., Kirchner, M., 2024a. Modelling national pathways to achieving the SDGs in Austria − Insights from a system simulation approach with focus on inequality, economic growth and climate mitigation. https://sdg.visionpath.at/wp-content/uploads/SDGVisionPath_WP4b.pdf

Working Papers available at our website

- *Working Paper No. 2a:* Hinterberger, F., Payerhofer, U., Muhr, M., Janu, R., Bukowski, M., Palmetshofer, G., Fingerlos, I., 2024b. Vision and Goals - Where do we want to go? https://sdg.visionpath.at/wp-content/uploads/SDGVisionPath_WP2a.pdf
- *Working Paper No. 2b:* Hinterberger, F., Bukowski, M., Fingerlos, I., 2024a. Indicators - How do we measure whether we are achieving our goals? https://sdg.visionpath.at/wp-content/uploads/SDGVisionPath_WP2b.pdf
- *Working Paper No. 3:* Bukowski, M., Hinterberger, F., Palmetshofer, G., Kirchner, M., 2024. Pathways - How do we get there? https://sdg.visionpath.at/wp-content/uploads/SDGVisionPath_WP3.pdf
- *Working Paper No. 5:* Palmetshofer, G., Wretschitsch, E., Spittler, N., Bukowski, M., Hinterberger, F., Kirchner, M., 2024. Communities of Practice: Visualizing Co-Creation with Figures and Lines of Thought. A Working Tableau. https://sdg.visionpath.at/wp-content/uploads/SDGVisionPath_WP5.pdf?

Presentations at scientific conferences

- *24. Österreichischer Klimatag (Austrian climate day)*, 02.-04.04.2024, Vienna
  Oral presentation by Mathias Kirchner
  Title: SDGVisionPath - Co-Creating future visions and transition pathways for the SDGs climate action, inequality and decent work and economic growth
  https://ccca.ac.at/dialogformate/oesterreichischer-klimatag/klimatag-2024
- *22nd Annual STS Conference Graz 2024 „Critical Issues in Science, Technology and Society Studies"*, 06.-08.5.2024, Graz
  Presentation by Eva Wretschitsch
  Title: Pathways towards a future vision: A systems based and stakeholder integration approach to avoid socio-environmental conflicts in combating climate change
  https://www.tugraz.at/tu-graz/services/news-stories/tu-graz-events/eventdetails/article/sts-conference-graz-2024

- *42nd International System Dynamics Conference*, 04.-08.08.2024, Bergen, Norway
  Presentation by Eva Wretschitsch
  Title: Pathways towards climate targets – What synergies arise in the context of the Sustainable Development Goals (SDGs)?
  https://systemdynamics.org/event/2024-international-system-dynamics-conference/
- *10th International Degrowth Conference and the 15th Conference of the European Society for Ecological Economics(ESEE)* Science, Technology, and Innovation beyond growth: Cultivating collective creativity for a sustainable future, 18 – 21 June 2024, Pontevedra, Spain, https://esee-degrowth2024.uvigo.gal/en/
  Presentation by Friedrich Hinterberger, Coauthor: Meike Bukowski
  Title: Measuring progress of a wellbeing economy bottom-up from micro to macro.
- *50th anniversary of the European Center for social Welfare Policy and Research*,
  invited guest speaker of the conference, 26.09.2024, Vienna
  https://www.euro.centre.org/downloads/detail/5013
  Presentation by Meike Bukowski
  Title: Building bridges between science and politics.
- *Open Lecture PLUS & Scientist4Future "Open your course for climate change"*, 08.05.2024, Salzburg, Austria (in cooperation with the Mozarteum, and the University of Applied Science Salzburg, UniNEtZ)
  https://www.moz.ac.at/de/veranstaltungen/2024/05/08-nachhaltige-wohn-t-raeume-in-salzburg
  Presentation by Meike Bukowski
  Title: Nachhaltige Wohn(t)räume in Salzburg (on energy poverty and GHG emissions – affordable and climate friendly housing)
- *UNGA78 SDG Science Summit Session*, Organisation (Convenior Friedrich Hinterberger), in cooperation with the Club of Rome as well as UniNEtZ and SDGVisionPath, 20.09.2023, New York
  https://sciencesummitunga78.sched.com/event/1Qs6V/in-person-earth-for-all-earth-for-all-turnarounds-to-reach-sdgs-implementation-transdisciplinary-sdg-modeling-approaches-for-action-in-kenya-austria-200904?utm_medium=email&utm_source=admins&utm_campaign=global-welcome-invited-B
  Keynotes by Friedrich Hinterberger, Nathalie Spittler, Meike Bukowski
  Titel: Earth for all - Earth for all? Turnarounds to reach SDGs Implementation: transdisciplinary SDG-modeling approaches for action in Kenya & Austria!.

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