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Post-Growth and the Lack of Diversity in the Scenario Framework

Rawad El Skaf

Post-Growth Economics Network

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Rawad El Skaf

Senior Fellow,
SOCRATES Centre for Advanced Studies in Humanities and Social Sciences
Hannover, Germany.
rawadskaff@gmail.com

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Abstract

Scenarios and pathways, as defined and used in the "SSP-RCP scenario framework", are key in last decade's climate change research and in the latest report of the Intergovernmental Panel on Climate Change (IPCC). In this framework, Shared Socioeconomic Pathways (SSP) consist of a limited set of alternative socioeconomic futures, that are both represented in short qualitative narratives and with quantitative projections of key drivers. One important use of the computationally derived SSP-scenarios is to do mitigation analysis and present a "manageable" set of options to decision-makers. However, all SSPs and derivatively SSP-scenarios in this framework assume a globally growing economy into 2100. This, in practice, amounts to a value-laden restriction of the space of solutions to be presented to decision-makers, falling short of IPCC's general mandate of being "policy-relevant and yet policy-neutral, never policy-prescriptive". Yet, the Global Economic Growth Assumption (GEGA) could be challenged and in practice is challenged by post-growth scholars. However, for post-growth mitigation scenarios to be constructed, explored, and assessed more systematically, they need to be fully integrated into the scenario framework. This is not done yet. I argue, from a philosophy of value-laden science perspective, that this should be done and propose two ways. This integration follows from and satisfies a diversity criterion, which derivatively enhances the framework's "objectivity" and the IPCC's policy-neutrality.

1. Introduction

In December 2023, the president of the 28th Conference of the Parties Sultan Al Jaber defended during an online debate that "there is no science out there, or no scenario out there, that says that the phase-out of fossil fuel is what's going to achieve 1.5C" (The Guardian, 3 December 2023). While much could be said regarding the inaccuracies and falsehoods in this statement, my focus in this paper is on the link between *science*, *scenarios,* and *policy* from a philosophy of science perspective.

There are many definitions of the concept "scenario" (Brewer 2007; Schwartz 1991; van der Heijden 1996, Selin 2006), but in all cases the emphasis is on the idea that scenarios are not predictions, and are not supposed to be true, but rather they are different projections of alternative futures which aim to be useful for formulating strategies and making decisions. Introduced by Herman Kahn in the 1960s, scenarios were first used to plan for aspects of nuclear warfare in the early Cold War period (Galison 2014). Since then, scenario-based science has been democratised, especially in research on topics with important societal and environmental consequences.

Why use scenarios in the context of climate change research? Research into climate change depends on a myriad of factors, but two categories of information are essential. The first is to know what changes are going to take place in a future climate. For instance, how much the temperature will rise over the course of the 21st century, how much the Arctic Sea ice will decline, what is the extent of the instability of polar ice sheets and the resulting additional sea-level rise. The second category of information essential to climate change research is the socio-economic structure of the future world. This latter will release a quantity of greenhouse gases (GHGs) and therefore further mitigate or exacerbate climate change. It will also suffer the various effects of climate change and try to adapt to its new environment. The complexity and the deep uncertainties characterizing these two systems taken separately – climatic and socio-economic – as well as the complexity of their interaction, make scientific prediction of these two futures impossible, even probabilistically. This has led climate change research to move towards a scenario-based science.

Scenarios could be individual; a researcher could imagine, design, and analyse scenarios for her own purposes. However, in a globally coordinated climate change research, shared *common* scenarios are needed to analyse and compare climate change mitigation, adaptation and impact studies by a highly interdisciplinary and international community. For that, the Integrated Assessment Modeling Consortium has coordinated the development of the "SSP-RCP scenario framework", which already served as the basis to thousands of research papers and projects (O'Neill et al. 2020) and the latest IPCC (Intergovernmental Panel on Climate Change) 6th assessment report (AR6). This will continue to be the case for the next AR7 report. In this framework, SSPs (Shared Socioeconomic Pathways) consist of a limited set of alternative socioeconomic futures that are both represented in short qualitative narratives and with quantitative projections of key drivers. However, all five SSPs share a common Global Economic Growth Assumption (GEGA). That is, all current SSPs assume, with varying degrees, that the economies of the Global North and those of the Global South will keep on growing until the end of the century.

This results in the following well-known problem: GEGA is both historically and theoretically tightly correlated with GHG emissions. SSP-based mitigation scenarios, both consistent with GEGA and aim at achieving 1.5°C or below 2°C targets complying with the Paris Agreement, need to find ways to solve this problem. These solutions tend to be either (a) *negative emissions-oriented mitigation scenarios*, which means that they rely on some technology to remove GHG from the atmosphere in the future, or (b) *decoupling-oriented mitigation scenarios*, which means that they mainly rely on the contested hypothesis that one could absolutely decouple economic growth and GHG emissions, or more generally the assumption that economic growth can continue while reducing environmental harm.

This is not just a scientific problem; mitigation scenarios are a central science for policy tool. They aim at presenting decision-makers with a range of a "manageable" set of options to achieve a certain mitigation target. This is done to a large extent via the IPCC's reports where "most of the scenarios in the AR6 database are SSP-based" (Riahi et al. 2022, p.305) and Edenhofer and Kowarsch's (2015) Pragmatic-Enlightened Model (PEM) model. However, having only SSP mitigation scenarios consistent with GEGA restricts the range of solutions in a *value-laden* manner, contrary to the IPCC's general mandate of being "policy-relevant and yet policy-neutral, never policy-prescriptive". This restriction is value-laden because GEGA is a value-laden assumption and could be challenged by appealing to different values, as evidenced by the "post-growth" [1] literature (e.g. Kallis et al., 2018; Kuhnhenn, 2018; Hickel, 2019; Otero et al., 2020; Keyßer and Lenzen, 2021; Hickel et al., 2021; Li et al., 2023; Kikstra et al., 2024; Slameršak et al., 2024). By relaxing GEGA for the Global North, post-growth scholars aim at proposing alternative mitigation scenarios. However, for these scenarios to be constructed, explored, and assessed more systematically, they need to be fully integrated into the scenario framework, something not yet done.

In this paper I argue that this integration could and even should be done. To spell out my argument, the paper is structured as follows. In section 2, I introduce the scenario framework and explain how SSP-scenarios are derived from SSP-pathways and are used to do mitigation (as well as adaptation) comparative analysis. Most importantly, in this framework an SSP-scenario needs to be consistent with an SSP-pathway, thus underlying the importance of GEGA in all five SSPs. In section 3, I critically present how scenarios are used to guide decision-making following Edenhofer and Kowarsch's (2015) PEM model. This approach promises to uphold IPCC's general mandate by deferring *controversial* value-laden judgements to decision-makers. Here I argue that by upholding GEGA in the theoretical framework and deriving only GEGA compatible mitigation scenarios, scientists are considering this assumption as *consensual*. However, GGEA is controversial and thus should be reflected in the mitigation options. In section 4, I reconstruct and synthesise in a single

[1] I will use the term post-growth and degrowth interchangeably in this paper.

deductive argument several criticisms coming from the post-growth literature and calling for the integration of their research into the scenario framework. I then propose two ways for doing this. In section 5, I argue that this integration enhances the diversity of scenarios that could be constructed under the scenario framework. This is important, since from a philosophy of a value-laden science perspective, diversity is a well-suited guide to "objectivity". Integrating post-growth into the scenario framework thus enhances this latter's objectivity and hence IPCC's policy-neutrality. I conclude in section 6 with some thoughts on plausibility, but defend that, in some cases (to which post-growth belongs), *diversity comes first*; for plausibility or feasibility assessment across dimensions (Brutschin et al., 2021) to be done correctly, they should be done *a posteriori.* For that, an integration of post-growth into the scenario framework is needed.

2. The SSP-RCP Scenario Framework

Since its first report, the IPCC has developed several generations of scenarios: SA90, IS92 and SRES. The newest generation of scenarios, "SSP-x-y" are the first to be outsourced and not developed directly under the guidance of the IPCC. The process of constructing and using SSPx-y scenarios is elaborated in the scenario framework. This latter began in 2010 (Moss et al., 2010) and was completed and published in a special issue of *Global Environmental Change* in 2017 (see Riahi et al., 2017 for an overview) for use in the latest IPCC's AR6 report. This new conceptual framework promises to combine two elements in the matrix architecture illustrated in Figure 1.

2.1 The scenario framework matrix architecture

The lines in the matrix of figure 1 contain the RCPs (for Representative Concentration Pathway). The RCPs span the range of radiative forcing values, which is a measure of changes in the net transfer of energy in the atmosphere. Each RCP represents a concentration level of GHG, which are the main input for climate models to project future climate behaviour, in particular for determining global temperature increase. Because of the uncertainty about future emissions and concentration of GHGs, different RCPs are studied by climate scientists, ranging from 1.9 W/m² (which corresponds approximately to the Paris Agreement target of 1.5°C) to 8.5 W/m² (which corresponds approximately to a temperature rise of 4.3°C). These differences depend on the future global socioeconomic structure that emits GHGs and uses land. These latter are described by the SSPs, which will be the focus of this paper.

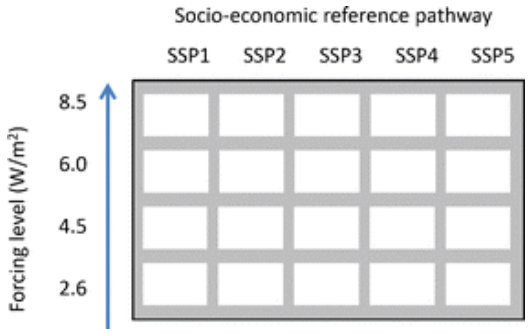

Figure 1: SSP-RCP matrix architecture (Van Vuuren et al. 2014)

The columns contain the SSPs. Seeing that the long-term evolution of the current socioeconomic structure of the world is highly uncertain, the Integrated Assessment Models community conceived of five different and alternative ways this evolution might occur, which they labelled SSP 1 through

5. The hope is that these five SSPs describe future evolution of key aspects of society in which different policy responses to climate change could be implemented with different degrees of challenges for mitigation and adaptation (figure 2). Challenges for mitigation are socioeconomic factors that would make the "mitigation task easier or harder for any given target [i.e. RCP] and mitigation policy". On the other hand, challenges to adaptation are "defined as societal or environmental conditions that, by making adaptation more difficult, increase the risks associated with any given projection of climate change" (O'Neill et al 2014). My focus in this paper will be on mitigation.

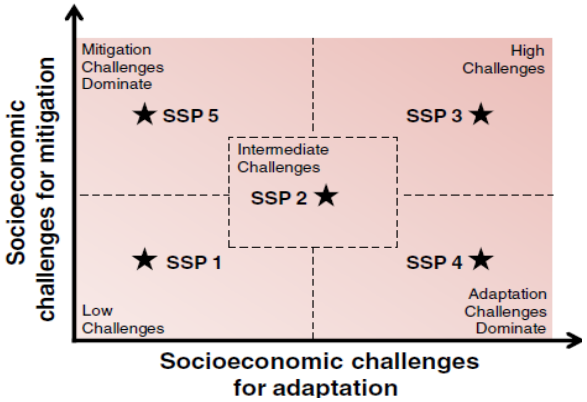

Figure 2: Five SSPs representing different combinations of challenges for mitigation and adaptation (O'Neill et al, 2017)

Each SSP begins with a narrative of an alternative socio-economic future where the relevant factors that are assumed to pose challenges for mitigation and adaptation are described qualitatively. Many elements were discussed in several expert meetings and ultimately "variables in six broad categories were considered to be important to represent in the SSPs: demographics, human development, economy and lifestyle, policies and institutions (excluding climate policies), technology, and environment and natural resources" (O'Neill et al. 2017). As an illustration, consider the most optimistic SSP:

> SSP1 Sustainability – Taking the Green Road (Low challenges to mitigation and adaptation). The world shifts gradually, but pervasively, toward a more sustainable path, emphasizing more inclusive development that respects perceived environmental boundaries. Management of the global commons slowly improves, educational and health investments accelerate the demographic transition, and the emphasis on economic growth shifts toward a broader emphasis on human well-being. Driven by an increasing commitment to achieving development goals, inequality is reduced both across and within countries. Consumption is oriented toward low material growth and lower resource and energy intensity. (Riahi et al 2017, see O'Neill et al 2017 for the long versions).

The narrative main function is to describe an internally consistent story of the future (Riahi et al, 2017) which is done both informally through expert meetings as well as formally with Cross-Impact Balance method (see Schweizer and O'Neill 2014, Lloyd and Schweizer 2014, O'Neill 2017). The internal consistency of the narrative is crucial, seeing that there are many elements which causally interact in each narrative. For instance, if a narrative describes a world in which education level is high and GDP growth is also high, this world is expected to also have a low fertility rate. A narrative that assumes a high population growth is thus inconsistent with high levels of GDP and education.

Narratives thus describe broad future socioeconomic trends in a consistent manner. These elements are described qualitatively in the SSP narratives. While some, such as the quality of institutions, political stability, and environmental awareness can only be described qualitatively, others such as population and economic growth could be quantified. So, to go further and be able to use these narratives as inputs to highly complex model-based computer simulations, the Integrated Assessment Models (IAMs), the community has proceeded to quantify some SSP elements. With these inputs, IAM generate baseline and mitigation scenarios as outputs. Pathway and scenarios play a distinct methodological role and raise distinct philosophical issues. Unfortunately, there is an ongoing confusion[2] in the literature between pathways and scenarios, and both are used interchangeably, in spite of the conceptual distinction we find in the scenario framework.

Pathways are defined as the conditions describing the rows and columns of the matrix, the RCPs and the SSPs, the "P" in RCP and SSP stands for "pathway". Pathways are not just the qualitative part of SSPs, as they also include quantifications of social drivers of GHG emissions. Four main drivers were quantified and harmonized with computational models; these are population, education, urbanisation and most importantly for my purpose in this paper, *GDP* (see Riahi et al. 2017). For Other SSP elements were left to be quantified by individual studies. As it will become clearer later (see 2.3), this is a crucial step, since it fixes each pathway in terms of these four harmonized drivers and greatly affects mitigation scenarios. So, what are scenarios and how do they differ from pathways?

S*cenarios* are defined as containing descriptions of a more complete and detailed future than pathways and are constructed by integrating an SSP and an RCP in a cell of the matrix. Scenarios come in two forms, *baseline* and *mitigation*. Baseline scenarios are obtained by imputing quantified pathways elements into IAMs to draw out their consequences in terms of GHG emissions, land use and energy systems. The process of building SSP baseline scenarios involved several IAMs, six to be precise. IAMs are complex computational models that simulate the interactions between different sectors like energy, economics, land use, and climate.

Economists play a key role in this interdisciplinary exercise; from constructing the SSP narratives, to quantifying their drivers and in constructing IAMs. This includes modelling economic growth, consumption, production, and investment, as well as interactions between these elements, that influence how SSPs describe the different ways global and regional economies could evolve over time. These assumptions are grounded in empirical data and economic models such as neoclassical growth models, CGE (Computable General Equilibrium) models, and input-output models are used to project future GDP growth, energy demand, and material consumption. Take, for example, the first GDP projection (which is now being updated). The process of quantifying GDP projections for each SSP comprised three different economic modelling teams. The OECD group led by Dellink used "ENV-Growth model", a neoclassical economic model and were selected as the representative 'marker' SSP to be used in all SSP quantification of GDP growth (Riahi et al., 2017).

By running IAMs with exogenous inputs from the first quantification, researchers can project their consequences. Doing this, the community obtained quantitative baseline scenarios. However, these IAMs are structurally different, for instance IAMs have unique economic modules, reflecting diverse approaches to representing economic systems, sectors, and feedback loops (see Weyant, 2017). In addition, different research groups used different values for variables other than the four harmonized ones. This produced different results for the same SSP by different IAMs. The community therefore

[2] For instance, in the AR6 summary for policymakers we read in a footnote that "[i]n the literature, the terms pathways and scenarios are used interchangeably, with the former more frequently used in relation to climate goals." While IPCC's Working Group I (WGI) primarily used the term scenarios, Working Group III (WGIII) mostly used the term mitigation pathways.

had to make a choice[3]: for each SSP, a single IAM was selected as providing a representative *marker* SSP baseline scenario to be used in future research (cf. Riahi et al., 2017). These scenarios describe how each SSP narrative would look like in terms of energy, land-use and GHG emissions *if no climate change impacts occur, nor climate policy responses implemented* beyond those already assumed in each SSP. Seeing that these latter elements determine the future radiative forcing level, each baseline SSP scenario is associated with an RCP level and thus with a different projected climate change. SSP1 baseline scenario is expected to result in an RCP level of 5W/m², whereas SSP5 baseline is expected to be around 8.5W/m², with the remaining SSP2, SSP3 and SSP4 ranging in between.

In sum, we start from an SSP-narrative, and we then quantify most of its elements and use IAMs to computationally derive SSP baseline scenarios. The distinction between pathways and scenarios is crucial in the scenario framework, seeing that it is scenarios, rather than pathways, that are used to do comparative analysis between baseline and mitigation scenarios (O'Neill et al 2014). This is done in the scenario framework by moving down columns and along rows in the matrix of figure 3.

2.2 Mitigation analysis with the scenario's framework

Mitigation and adaptation analysis are done by investigating what It would take to go down a column and along a row in the matrix (figure 3): mitigation studies may analyse how to reach different RCP targets – down a column in a particular SSP – by implementing different mitigation policies. On the other hand, Impact, Vulnerability and Adaptation studies may be interested in looking along a row and investigating how the impacts of climate change and the options for adaptation vary for the same RCP across a range of SSPs.

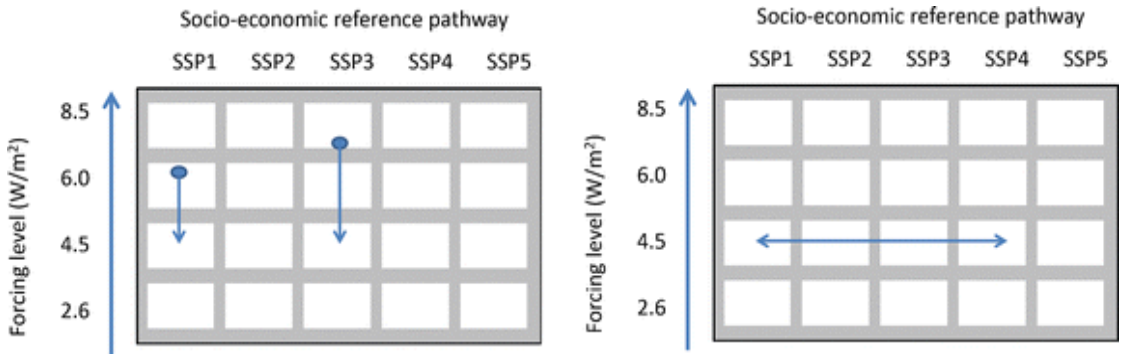

Figure 3: Mitigation and Adaptation analysis (Van Vuuren 2014, p. 385)

Mitigation studies are carried out in this framework with baseline and mitigation scenarios. These play distinct roles. It is important to remember that baseline scenarios are developed based on SSP narratives and their quantifications, but they do not include any specific climate policies additional to what is already in place in these SSPs. In essence, they represent a business-as-usual future for a particular SSP. Mitigation scenarios, on the other hand, are obtained by adding specific climate mitigation policies to a baseline SSP scenario. Mitigation scenarios are intentionally designed to achieve certain objectives, such as limiting global warming to 1.5°C (RCP 1.9) or below 2°C (RCP 2.6) above pre-industrial levels, in line with the objectives of the Paris Agreement. They provide an

[3] It is interesting to note here that these choices were neither dictated by scientific evidence nor by empirical data, but mainly by non-epistemic and pragmatic values.

overview of the technological and behavioural changes that would be required in a given SSP to achieve specific climate objectives specified by a given RCP level.

Baseline and mitigation scenarios thus serve as the basis for comparative analysis: by comparing a baseline scenario (with no new climate policies) and a mitigation scenario (with a specific RCP target and new climate policies), researchers can discern the gap between a baseline and the desired climate outcomes. This said, in this SSP-based mitigation analysis some mitigation options remain excluded, in particular those coming from the post-growth literature. To see that, one should understand how economic growth is embedded into the SSPs.

2.3 GEGA and consistency between SSP-scenarios and SSP-pathways

Sultan al Jaber continues his above declaration by asking some help: "Please help me, show me the roadmap for a phase-out of fossil fuel that will allow for sustainable socioeconomic development, unless you want to take the world back into caves." The underlying crucial assumption for this call for help is that we need mitigation scenarios that effectively reduce GHG emissions but also allow for sustainable socioeconomic development. The scenario framework shares this assumption in the following form: all five SSPs narratives share a GEGA to varying degrees. For simplicity, GEGA here refers to global growth of GDP (gross domestic product) or GDP per capita (the difference between their rates being negligible in the absence of quick population growth or decline) in both the Global North industrialized countries as well as in the Global South countries. SSP3 and SSP4 describe worlds with low GEGA, while SSP2, SSP1 and SSP5 describe worlds with higher GEGA. This is the case both for SSP narratives (O'Neill et al., 2017), and in their quantification by neoclassical economic models (Dellink et al., 2017, Koch et al, 2023). All SSP thus satisfy GEGA.

Most importantly, both baseline and mitigation scenarios are assumed to be and remain consistent with the SSP they are investigating. This is a different, but related, consistency requirement than the above internal consistency of the SSP narrative, which concerned the way qualitative elements are related *to each other*. This consistency concerns *each* element and its quantification, so if a narrative describes population growth as high, its quantification should also reflect this. These two consistency requirements are related, seeing that the first internal consistency between qualitative elements should also be reflected with an internal consistency between the quantification of these elements. For baseline scenarios, consistency between the narrative and its quantification and the resulting internal consistency of the scenario is an important feature of the scenario framework. Indeed, the five papers in the 2017 special edition in *Global Environmental Change* describe the quantification of each SSP: each paper describes how its own IAM quantified its marker SSP baseline scenario and each explicitly assesses, among other things, the consistency between this latter and the SSP they are investigating.

Things are more complicated for mitigation scenarios. Consistency between SSP assumptions and mitigation scenarios is a criterion briefly addressed in Kriegler et al. (2014). We can read in this paper that "care needs to be taken that SSPs and SPA[4] combination is consistent". However, two conflicting recommendations are given: (1) seeing that SSPs contain some reference assumptions that could be affected by climate policies, they need to be adjusted after a climate policy is introduced. (2) Some SSP reference assumptions will have implications for which climate policies are possible in a given SSP. For example, a narrative describing regional rivalry in a fragmented world (SSP3), "can hardly be paired with the assumption of a global carbon market" (Kriegler et al, 2014). Put differently, it remains unclear which reference SSP assumption could be relaxed following recommendation (1),

[4] SPA stands for Shared Policy Assumptions, which is yet a third axes in the scenario framework matrix, but for simplicity think of it as any mitigation policy, shared or not.

and which are not, constraining thus possible mitigation policies to ones consistent with a given SSP reference assumption, following (2).

One may expect that some mitigation policies would affect GDP growth in such a way that this latter becomes stagnant or negative. However, in current growth-oriented mitigation SSPs, GDP is both an input – coming from a baseline SSP – and an output of the IAM models calibrated to that input. Put differently, GDP growth is an exogenous[5] input in IAMs and the calculated GDP is calibrated to remain nearly the same in mitigation scenarios, consistent with the growth assumed in each baseline SSP (Li et al, 2023). In mainstream IAM literature, recommendation (2) is thus followed for economic growth: GDP growth is not taken to be a variable, but instead is "taken as a given, as a fact of nature so to speak" (Cointe and Poittier, 2023) that should not be altered, at least not "excessively". Indeed, altering GDP excessively could render the scenario inconsistent with other socio-economic drivers such as education and population, following the internal consistency requirement. In fact, GDP losses are calculated in SSP mitigation scenarios, and they vary depending on the SSPs. For instance, "SSP3 has the highest annual GDP losses rate across all three climate mitigation scenarios in 2100, at 8.8%, 6.7%, and 3.2% for the SSP3-3.4W, -4.5W, and -6.0W scenarios, respectively. The corresponding GDP losses are much lower in SSP2 (1.4%, 1.0%, and 0.2%) and even lower in SSP1 (0.5%, 0.3%, and zero)" (Calvin et al, 2017). However, and most importantly, the order of magnitude GDP losses due to cost of mitigation "represents a negligible number when put in the perspective of economic growth over the century […] emphasizing that steady economic progress is consistent with reaching the climate goals of the Paris Agreement," (Köberle et al, 2021).

This results in a well-known problem (e.g. Kuhnhenn, 2018): GEGA is tightly correlated both historically and theoretically with GHG emissions, making it difficult to reconcile GEGA with ambitious mitigation objectives complying with the 1.5°C or 2°C target. SSP mitigation scenarios that promises to achieve this reconciliation, tend to postulate either (a) negative emissions technologies to remove GHG from the atmosphere in the future, or rely on (b) energy efficiency solutions which results in an absolute decoupling of GDP growth from GHG emissions. Sometimes both (a) and (b) are assumed. These solutions are not simply a scientific exercise, but also have important concrete policy and societal consequences. Indeed, the main purpose of these mitigation scenarios and comparative analysis is to provide decision-makers with a scientific basis to guide their decisions. It is also argued that this scenario-based advice is in line with the IPCC's stated general mandate of being "policy-relevant and yet policy-neutral, never policy-prescriptive". However, if the scientific processes and results are value-laden – as many researchers now admit, particularly following the argument from inductive risk by philosophers of science (e.g. Douglas 2000, Rudner 1953) – this raises the question of how reasoning with scenarios can serve as a guide to policy upholding this mandate. Let me spell out this in the context of a prominent model that aims at providing a way for scenarios to be used as a neutral guide to policy.

3. Cartography approach to science for policy

The influence of non-epistemic values – e.g., moral, cultural, and political values – in virtually every stage of scientific processes is well documented by scholars, especially when the science in question has an important social and environmental consequence. In the case of climate change research, philosophers of science have focused on the role of non-epistemic values in *models*, both climate models and IAMs (see for e.g. Frisch, 2013, Biddle & Winsberg, 2009; Winsberg, 2012; Intemann, 2015; Winsberg, 2018; Parker and Lusk, 2019; Jebeile, 2020, Tavoni and Valente 2020). In the case of economics, philosophers of science and economics have also debated if the field should even be

[5] For some IAM, GDP is endogenous, but its calculation is driven by exogenous variables such as labour productivity increases and is expected to be consistent with the SSP assumed economic growth (see Cointe and Poittier, 2023 for more details)

methodologically conceived as a value-free or a value-laden one (e.g., Reiss 2017; Małecka, 2021). Despite this, little has been said about the role of values in climate change scenarios and pathways. In general, once the influence of non-epistemic values in science is acknowledged, there are two ways for managing them, which can be divided into two camps. Either accept that science is value-laden or argue for a value-free/value-neutral science. There are several proposals of how one goes about theorizing the former (e.g. Longino 1990, Douglas 2000 and Kitcher, 2011), my focus in this section will mainly be on the latter.

Recognising the importance of non-epistemic values in science, some approaches propose that we should take controversial value-laden decisions out of the hands of scientists by *deferring them to decision-makers* (Havstad and Brown, 2017a). One highly influential approach for doing this with scenarios is the Pragmatic-Enlightened Model (PEM) coming from the IAM community (see Pielke 2007 "honest broker" for a similar approach). In parallel with the development of the scenario framework, the PEM model of science-policy interaction was developed by Edenhofer (co-director of the IPCC's third working group, WGIII, 2008-2015) and Kowarsch in 2015. This model is widely used by the IPCC, in particular by WGIII. WGIII is also the IPCC working group in which IAMs are widely used and the IAM consortium is the most influential. Under the PEM approach, experts provide decision-makers with a "cartography of pathways" with different policy objectives and the means to achieve them. Both the objectives – which RCP to be targeted – and the means to achieve it – which mitigation policies to adopt – are recognised to be value-laden. Aiming for the objective of 1.5°C or below 2°C targets as well as what mitigation policy to implement to achieve these targets are both value-laden decisions. One motivation of the PEM according to its authors, is indeed to propose a model that manages the influence of controversial non-epistemic values in science. Whenever there is a controversy around values, PEM requires building different options exemplifying these controversial values and deferring the judgement to decision-makers: the scientist remains neutral in a way, not recommending which scenario, and thus controversial values, to adopt.

However, following Havstad and Brown (2017a), the danger of these approaches is that they

> adopt a posture of neutrality, but they must in practice present a narrow, greatly simplified space of options. The presentation of options under the guise of neutrality serves to obscure, rather than highlight, the value-laden series of decisions that precedes the presentation of those same options.

The posture of neutrality consists of scientists presenting decision-makers with different mitigation scenarios, *as if* the different options exemplify *all* relevant controversial non-epistemic values. However, the set of options presented to decision-makers, being narrowed down so that it can be managed, cannot contain *all* relevant controversial non-epistemic values, except in very simple cases, which is not the one of the IPCC's. Acting as if this set is exhaustive, obscures the series of value-laden decisions taken in the narrowing down process.

GEGA is part of the narrowing down process, as evidenced by the fact that all SSP mitigation scenarios remain consistent with GEGA. However, GEGA is narrowing down the options at a high theoretical level. For when Havstad and Brown (2017a) or Edenhofer and Kowarsch (2015) talk about the process of narrowing down, what they have in mind is reducing the number of scenarios from 1202 (Riahi et al. 2022, p. 298) in the AR6 database to a representative handful[6] that are manageable by decision-makers. While with GEGA, this narrowing down is done at a higher level and restricts

[6] In AR6 WGIII chapter 3, this is done with the concept of "Illustrative Mitigation Pathways", these are 5 or 7: In this paper I referred to SSPx-y when talking about mitigation scenarios seeing that my purpose here is the theoretical foundation of the scenario framework. This said, IMPs reflect SSPs because they are an aggregation of the SSP-based scenarios submitted to the AR6 database.

the space of possibilities in the process of construction of these 1202 scenarios. This is made explicit in AR6 WGIII chapter 3 on mitigation: most scenarios in the database are SSP-based and "economic degrowth are not fully represented, as these scenarios, with a few exceptions, were not submitted to the database." (Riahi et al, 2022, p. 383). These 1202 scenarios are thus already narrowed down in a value-laden manner, before they get narrowed down even further. This is in essence a *posture of neutrality* and obscures rather than highlights the value-laden decision taken by scientists on a controversial value: GEGA.

Here lies the problem: by excluding post-growth options, GEGA is implicitly presented as an uncontroversial value. It is adopted by scientists; it does not appear in the different options presented to decision-makers. But GEGA is a controversial value, as evidenced by post-growth approaches. For the scenario framework to be able to uphold neutrality by deferring controversial value-laden judgements following the PEM account, scenarios satisfying GEGA as well as post-growth scenarios challenging GEGA need to be explored and presented to decision-makers. For that, an integration of post-growth into the scenario framework is needed.

I will argue in favour of this integration in the next sections. It should be noted before that reconsidering GEGA as a controversial value is only a necessary condition, not a sufficient one for PEM to succeed in deferring all controversial value-laden decisions. Indeed, GEGA is just one instance of a controversial value-laden decision used to narrow down the options before they are presented to decision-makers. If that is correct, then deferring all controversial value-laden judgements to decision-makers so that scientists remain neutral is an unattainable ideal, except in simplified cases. It is even an undesirable ideal, if this deferred decision is to be taken solely by the currently elected Global North politicians. Indeed, most Global North's elected politicians are growth-oriented and a science that defers this value judgement to them will be able to explore only a limited set of options, to say the least. More importantly, this approach overlooks other stakeholders who find the GEGA undesirable, for example decision-makers in the Global South, local decision-makers, and a significant part of the world's population.

4. Integrating post-growth into the scenario framework

Scholars working on degrowth, post-growth and beyond growth mitigation scenarios (e.g. Kallis, G. et al., 2018; Kuhnhenn, 2018; Hickel 2019; Otero et al, 2020, Keyßer and Lenzen 2021, Hickel et al, 2021) share some version of the following argument:

> **(1)** All SSP pathways in the scenario framework satisfy GEGA
>
> **(2)** In order to achieve below 1.5 or 2°C target with GEGA satisfied, SSP mitigation scenarios need to be either
>
> > **(a)** negative emissions-oriented, that is they rely on non-existent or not sufficiently scaled technology to remove GHG from the atmosphere in the future such as direct air carbon capture and storage, and bioenergy with carbon capture and storage, or
> >
> > **(b)** Decoupling-oriented, that is they rely on a sufficiently fast and scaled absolute emissions-GDP decoupling[7], such that emissions decline as GDP grows.

[7] Absolute decoupling postulate that the efficiency of resource use, in particular energy production, could enable economic growth while reducing the use of natural resources and GHG emissions. (see, for e.g. Huen and Brockway, 2019, Otero,

(3) If 2(a) or 2(b) fail, we will be locked into a high temperature future

(4) Only alternative SSP pathways that do not satisfy GEGA enable modelling alternative SSP-based post-growth mitigation scenarios, different from 2(a) and 2(b)

(5) From a precautionary approach one must explore alternative post-growth mitigation scenarios

(**6)** For SSP-based post-growth mitigation scenarios to be constructed and explored, we must add an alternative post-growth compatible SSP pathway

This is a valid deductive argument; if the premises are justified, then conclusion (6) follows deductively. The premises are justified. Premise (1) describes the current state of the scenario framework as described in section 2. Premise (2) is a consequence of satisfying GEGA as explained in 2.3 and reflects a consensus in the climate change community, coming from both IAM community (e.g. Van Vuuren et al. 2018) and post-growth scholars (e.g. Keyßer and Lenzen 2021, Slameršak et al. 2024) and is reflected in the AR6. Both premises are justified. The consequent of (3) is justified by decades of climate science that links GHG emissions or concentration to temperature increase. One only needs to accept that options 2(a) and 2(b) *might* fail, to accept the antecedent of (3). Hence premise (3) is justified. Premise (4) is a consequence of satisfying the consistency requirement in (2.3). Premise (5) builds on a precautionary approach[8] (Hickel et al, 2021) which calls for alternative solutions to be taken seriously in face of uncertainties surrounding growth-oriented solutions and the catastrophic consequences that result from their failure (from premise 3). This is a deductively valid argument, and so one must either reject a premise or accept the conclusion in (6).

To my mind there are two ways: Either (section 4.1): reject the conclusion and keep the current five SSPs by challenging premise (4). Or accept the conclusion: include a post-growth SSP (section 4.2) and build new IAMs (section 4.3). Both these approaches integrate post-growth into the scenario framework, but to a different extent.

4.1 Relaxing consistency with GEGA for mitigation scenarios

This move consists in rejecting the conclusion, by challenging premise (4): Only alternative SSP pathways that do not assume GEGA enable modelling alternative SSP-based post-growth mitigation scenarios, different from 2(a) and 2(b). Remember from (2.3), an important feature of SSP-scenarios is that they need to be both internally consistent and quantitatively consistent with the SSP narrative they assume. Hence, any scenario in which GDP degrows, will be neither internally consistent nor its quantification consistent with any of the five SSP narratives. However, as also noted in 2.3, some variables need to be adjusted in the SSP so as to reflect the consequences of introducing a given mitigation policy. Here, post-growth scholars challenge that we should maintain the consistency of GDP growth for mitigation scenarios. For instance, Li et al. (2023) start with SSP2 baseline scenario but relax the consistency requirement for GDP. For that, they modify the MESSAGE IAM and use it to explore degrowth scenarios by mainly discarding the exogenous GDP trajectory. Doing this amount to turning GDP from an exogenously fixed parameter into an endogenous variable. In practice, they first deleted in the model the scaling of the calculated GDP to the exogenously imposed

2020, Haberl et al, 2020, Hickel and Kallis, 2020, Brockway et al., 2021, Hickel et al, 2021, Hickel and Hallegate, 2022, Vogel and Hickel, 2023;, Slameršak et al, 2024 for a critical analysis of the feasibility of the level of absolute decoupling needed).

[8] I intentionally use the term approach instead of "principle", seeing that there are many formulations of the precautionary principle out there.

GDP trajectory of SSP2. Then they modified the embedded utility function from a monotonic one to a non-monotonic one in which utility peaks at different consumption levels. In this version, different peaking locations determine different evolutions of the GDP under SSP2 assumptions (except that of GDP), with some results in a degrowing GDP. With that, they were able to explore how much aggregate production, energy and GHG emissions are reduced compared to the baseline non-modified SSP2.

This said, relaxing consistency requirements in mitigation scenarios for GDP growth and modifying IAMs accordingly should only be considered as a first step, because these modelling exercises "only captures some dimensions of degrowth and hence cannot be said to fully implement a degrowth scenario." (Li et al., 2023). These approaches amount to using only one SSP as a business-as-usual pathway (SSP2, which is already used in the majority of IAM mitigation scenarios), and the rest are considered as mitigation scenarios. To fully explore post-growth scenarios, both a new SSP and new IAMs seem to be needed. Hickel et al., (2021) call for that explicitly: "The SSPs and Integrated Assessment Models should be updated, or new ones created, to incorporate frameworks developed by research in social metabolism, industrial ecology, and ecological economics, so that post-growth scenarios can be successfully modelled." This echoes my conclusion (6) in the above argument.

4.2 Including a post-growth SSP

A new post-growth compatible SSP narrative is needed because in the current framework lower economic growth is currently associated with high challenges for mitigation and adaptation. For instance, both SSP3 and SSP4 have slower economic growth rates, but both describe a world with deepening inequalities, regional rivalries, and less technological innovation. As a result, IAMs could not achieve the 1.5°C target when implementing SSP3 and they barely do so when following SSP4 (Rogelj et al., 2018). But things need not be this way, post-growth scholars argue that in a post-growth compatible SSP, challenges for mitigation will be *easier* (e.g. Hickle et al. 2021). However, saying this is one thing, but building and exploring how this socioeconomic future might look like is another.

Why need a narrative? An SSP narrative function is mainly to provide an internally consistent story that connects the elements described in it and remain consistent when quantified (see 2.1). Remember these elements are usually fixed exogenous parameterized inputs for IAMs. There are hundreds of them, and a qualitative narrative is crucial to check for the consistency of the quantified combination of these elements, inputs to IAMs. For instance, one cannot have a consistent post-growth narrative in which the economy shrinks while well-being remains consumption oriented. In many IAMs, the economic module incorporates a utility function that represents the well-being of households or society. Utility is typically a function of consumption, where agents seek to maximize consumption over time (see Li et al, 2023, Kikstra et al., 2024). Indeed, a crucial demand for post-growth is to show how a non-growing Global North economy could function in such a way that well-being for all is maintained. For that, it is important to include in the narrative, for instance elements that permit inclusion of policies for the redistribution of income, wealth and work (Kuhnhenn, 2018) and many more.

However, despite an explicit proposal to add a new "beyond economic growth" SSP0 narrative with some of these elements (Otero et al, 2020), such an SSP is still not yet part of the SSP possibility space of the scenario framework. Even though Otero and colleagues focus on biodiversity, not on socioeconomic challenges for mitigation and adaptation, their proposal still shows how a post-growth compatible SSP narrative could look like. This SSP0 describes a world in which the society shifts its concerns beyond economic growth. It constitutes an interesting starting point to reflect upon which elements to add and which to remove, in a consistent way. Guiding thus the process of building a more detailed or better-suited post-growth SSP that focuses on challenges for mitigation and

adaptation. However, as explicitly stated in O'Neill et al. (2020) – a review paper by the scenario framework authors on the achievements and needs of their framework – this is not done. Referring to Otero's et al (2020) proposal to include SSP0, O'Neill et al (2020) only reply that "futures with no or limited growth in high-income countries […] are not represented in the SSPs" but acknowledges that a review and re-evaluation of the SSPs might be needed. Be that as it may, four years after this is still not done, even though this possibility of exploring a post-growth narratives found its way in the AR6, albeit in an annex in WGIII: "A wider range of narratives describing alternative worlds is also conceivable […] sustainability worlds with low growth or even elements of degrowth in developed countries could also be explored" (IPCC, 2022: Annex III, p.56).

Considering all this, why is an explicit post-growth compatible SSP narrative not yet included in the scenario framework? There are of course many political and normative reasons, but are there some methodological ones? Methodologically, the current five SSPs fill the whole possibility space of challenges for mitigation and adaptation (see figure 2). To integrate a post-growth SSP into the scenario framework one need thus to either shrink the region spanned by the five SSPs, as shown in figure 4 or modify an existing SSP and keep the space of the five SSP as in figure 2.

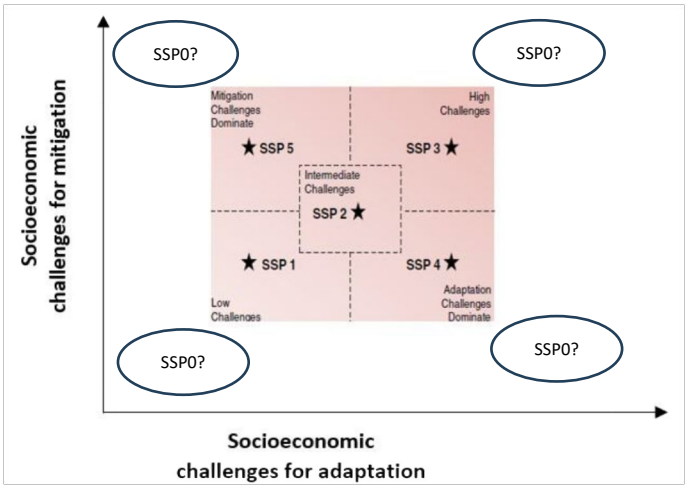

Figure 4: An alternative proposal to add a post-growth compatible SSP

Things are not that straightforward. For both solutions a theoretical reflection on the SSP elements that were included is needed to enable the construction of a post-growth SSP narrative. Wood et al (2024) propose to do exactly this in a recently published paper that aims at developing a new post-growth-oriented SSP. They detail in a table "qualitative assumptions that rely on reframing, altering or redefining the original markers" which are aimed "for the IAM community to use in the IPCC's AR7". For instance, we read that instead of focusing on GDP growth in traditional SSP, one could adopt the following indicators:

> Measurement of social and environmental progress may take the form of a more comprehensive dashboard of relevant indicators that centre socioecological provisioning (including care work and climate change mitigation and adaptation). A suite of metrics such as the Better Life Index (BLI), Environmental Performance Index (EPI), and Gross National Happiness (GNH) may be used to assess human wellbeing, environmental health and ecosystem vitality. BLI measures quality of life and identifies inequalities between top and bottom performers in OECD countries across 12 dimensions. EPI gauges environmental

performance relative to established policy targets using 32 indicators across 11 issue areas. GNH uses societal happiness as the primary lens for monitoring human progress within planetary limits across 33 indicators.

This is in line with AR6's recognition to shift away from taking monetary value of income growth as a measure of wellbeing. In the FAQ of chapter 5 of WGIII, to the question "Is demand reduction compatible with growth of human well-being?", authors of chapter 5 on demand, services and social aspects of mitigation answer in accordance with post-growth literature that "there is a growing realisation that mere monetary value of income growth is insufficient to measure national welfare and individual well-being. […] Many solutions that reduce primary material and fossil energy demand, and thus reduce GHG emissions, provide better services to help achieve well-being for all" (Creutzig et al. 2022, p.107). Even though these solutions *provide better services*, most of the elements needed to explore these solutions are not part of the current SSPs. These are crucial to include in a post-growth compatible narrative. The decision on what to include in the SSPs and what to discard are partly value-laden ones.

4.3 Developing New IAMs

Any SSP narrative needs to be explored further by quantifying its elements and computationally deriving baseline scenarios and exploring the effectiveness of mitigation policies. This will also be the case for a post-growth compatible SSP. However, modelling post-growth turns out to be "highly challenging, partly because a degrowth society would function differently compared to the current society" (Keyßer and Lenzen, 2021). The lack of IAM capable of producing degrowth scenarios is thus not purely reducible to value-laden decisions taken in the historical process of IAM construction and deciding on what and how to model, but also because these IAM best represent past and current functioning of most societies.

Lack of post-growth IAMs has practical consequences on researchers interested in exploring post-growth scenarios. For instance, Keyßer and Lenzen (2021) found that their analysis, which relies on a simplified IAM, needs to be complemented by a more complex one. Another recent effort to model degrowth scenarios with an existing IAM and that builds on and expands Li et al. (2023) approach discussed in section 4.1, arrives also to a similar conclusion: "no currently available model is perfectly geared to answer the complex questions that come with quantifying degrowth transitions in full" (Kikstra et al, 2024). This said, some EU-funded research projects on post-growth (e.g. LOCOMOTION and REAL) are aiming explicitly at developing new post-growth IAMs, with results still to be expected. Hence the importance of adding a narrative that qualitatively describe post-growth society, so to guide IAM in their modelling. This is an iterative process: the narrative informs the IAM that informs the narrative and so forth so that both IAM and narratives are co-developed.

In sum, this integration is needed to build and explore alternative post-growth mitigation scenarios. This integration is laudable, as it will in turn enhances *diversity*, to which I now turn.

5. Diversity as a guide to objectivity

Diversity, value-laden oriented philosophers of science argue, is a key criterion to track for articulating a value-laden interpretation of "objectivity" (see for e.g. Harding, 1992; Longino, 2002; Oreskes, 2019). This becomes crucial if one wants the scenario framework to be as objective as possible, so it can provide the IPCC with the necessary scientific framework enabling it to uphold its mandate of being *"policy-relevant and yet policy-neutral, never policy-prescriptive"*. Havstad and Brown (2017b) systematically analyse the different interpretations the criterion of policy-neutrality

could take, in conjunction with the other components of IPCC's mandate: policy-relevant and never policy prescriptive. They first criticise both the value-free interpretation and the deferred response interpretation of policy-neutrality à la PEM (or Pielke's honest broker) account. However, they also didn't find it fitting to interpret IPCC's policy-neutrality in terms of different value-laden interpretation of objectivity, including Douglas' value-neutral or detachment interpretations. They first note that Douglas (2004) detachment or Anderson (2004) non-dogmatism concern the ways the reasoning process are being conducted in a value-laden science and recommend that one should avoid situations where values "drive inquiry to a pre-determined conclusion" Anderson (2004). They then argue that this process-detachment does not provide the correct basis for understanding IPCC's claim of policy-neutrality. Indeed, a process-detached scientific inquiry "can have as their result a judgment for or against certain policies—in other words, they can be policy-prescriptive". If that's correct, then policy-neutrality as process-detachment is no longer consistent with the other part of the mandate of never being policy-prescriptive. Havstad and Brown (2017b) conclude thus that policy-neutrality could only be interpreted as a redundancy to never prescriptive "containing something of a repetition (probably for the sake of emphasis), or a suppressed "that is" (as in "policy-neutral, that is, never policy-prescriptive")".

However, there remain several philosophical interpretations of objectivity that went unanalysed by Havstad and Brown (2017b); those that emphasizes the crucial role of diversity as a guide to objectivity in a value-laden science. The relevant diversity here is to be understood in both "cognitive" as well as "social" senses, identified by Rolin (2019):

> A community or a group is cognitively diverse when its members have, for example, different research styles and skills, different perspectives on the subject matter of inquiry, or access to different bodies of empirical evidence. A community or a group is socially diverse when its members have different non-epistemic values, such as moral and political values, or different social locations, such as gender, ethnic identity, nationality, and race.

Post-growth call for diversity fit both senses, even if in the field of climate change mitigation this demarcation is hard to maintain. To illustrate this point, consider again the disagreement around how to measure well-being. We find that in the current SSP framework GDP per capita growth is used as one of the key indicators to measure well-being, and hence any mitigation scenario that promises to maintain well-being must not reduce excessively GDP growth and hence remain consistent with GEGA. Post-growth scholars disagree and provide alternative ways for measuring well-being. In these approaches, well-being would be measured in terms of specific social and environmental indicators, rather than in monetary terms, as for instance proposed by Wood et al (2024) above. Both parties need to collect different empirical evidence, seeing that their indicators are different. Both parties are thus cognitively diverse.

They are also socially diverse, seeing that in essence post-growth approach amounts to a call for a shift in non-epistemic values. What post-growth scholars are advocating is a shift away from a capitalist society and economic system that values rich people lives and income as well as prioritize wealth accumulation and resource extraction from the Global South to the Global North, or "from periphery to core" (Hickel et al., 2022), to one that values global justice and equality, (economic and climate) decolonisation (Hickel, J. and Slameršak, A. 2022; Hamouchene and Sandwell, 2023; Sultana, 2021, 2024), as well as social and environmental preservation, to name a few.

In light of this, Harding's strong objectivity (1992, 1995, 2015) seems to fit the bill, seeing that it emphasizes the importance of including diverse standpoints – particularly those of marginalized groups – into scientific inquiry (see Jebeile, 2020 for a similar analysis concerning climate models).

This is particularly relevant to our discussion, because "[s]tandpoint theories begin from the recognition of social inequality; their models of society are conflict models, in contrast to the consensus model of liberal political philosophy assumed by empiricists." (Harding, 1995). In addition, standpoint approaches argue that different perspectives come along with epistemic benefits. Ignoring them prevent scientists from accessing the epistemic advantages offered by certain standpoints and from producing knowledge that benefits marginalized groups in society. As Sultana puts it "[Our current system] ends up reproducing a knowledge system that is exclusionary and misses out not just a diversity of voices, but perpetuates the colonial practices of discounting of knowledge, lived experiences and wisdom from many global-south contexts." (Tandon, 2021)

While standpoint approaches reject neutrality (and impartiality), they can still serve as helpful guides to IPCC's mandate of being policy-neutral yet never policy-prescriptive. Standpoint objectivity can uphold IPCC's policy-neutrality by enhancing the scenario framework objectivity without prescribing outcomes: it recommends including diverse perspectives into the framework, strengthening thus the epistemic foundation of scenarios without dictating policies. To be sure, each mitigation scenario ends up prescribing some mitigation option over others, but the ensemble of scenarios remains policy-neutral. If the scenario framework's purpose is to serve as an objective guide to policymaking via the IPCC, then it must include more diverse perspectives that permits the construction of diverse mitigation scenarios. However, it should be clear by now that (1) the current coordination around SSP pathways and scenarios that satisfy GEGA excludes post-growth scenarios and thus reduces the scenario framework's objectivity. (2) Integrating post-growth mitigation scenarios into the scenario framework improves diversity and hence enhances the framework's objectivity à la Harding. It should be noted here that this integration only enhances objectivity, it is a necessary condition, not a sufficient one, seeing that other approaches could remain excluded from this framework, be them desirable or not.

Finally, and relatedly, lack of diversity results in what philosophers of science have identified as "epistemic inequality" in the context of climate models (Parker and Winsberg 2018, Jebeile and Crucifix, 2021) and "epistemic injustice" (Fricker, 2007). Epistemic inequality tends to represent concerns prioritised by the values of a given community – growth-oriented – at the expense of others – post-growth. Epistemic injustice concerns the ways in which individuals are unfairly marginalized. Indeed, post-growth mitigation scenarios are studied at the frontier of the scientific community, by being excluded from the scenario framework.

Diversity is thus a positive criterion that enhances objectivity and reduces epistemic inequalities and injustices. In a slogan: "In diversity there is epistemic strength" (Oreskes, 2019). However, diversity comes with some dangers and opens the door for an "anything goes" philosophy. For diversity to play a positive role, it needs thus to be complemented by a *desirability* and a *plausibility/feasibility* criterion. The former is a heavily normative criterions and its analysis goes beyond the scope of this paper; I will thus conclude with some thoughts on plausibility/feasibility.

One way to manage controversial non-epistemic values in scenario-based science consists in finding a correct balance between two conditions that are pulling in opposite directions: (1) diversity and (2) plausibility. While diversity enables climate change researchers to consider a wider range of scenarios and pathways, plausibility narrows down this choice. Put differently, while diversity aims at encouraging different worldviews, and thus values, to be included in the set to be researched, plausibility narrows the outcome of this research to a size manageable by decision-makers. Until now, I mainly addressed the diversity criterion, for it is lacking. In the next section I argue that my focus on diversity is justified, seeing that *diversity comes first* in some cases, to which post-growth belongs.

6. Diversity first

We want a climate change science that considers *not any* scenario, but *plausible* ones. One could argue that diversity is an interesting criterion to have while doing research, as long as options presented to decision-makers are plausible enough. However, to assess plausibility of post-growth mitigation scenarios, these need to be fully integrated in the SSP-RCP scenario framework, so that comparative analysis with other mitigation scenarios could be carried out more systematically. For that, plausibility assessment should *be done a posteriori* and *diversity comes first*. Failing to integrate post-growth neglects alternative perspectives prematurely, thus limiting the spectrum of available potentially plausible policy options to address climate change mitigation. Worse, this results in a self-fulfilling prophecy (Keyßer and Lenzen 2021): without such mitigation approaches being integrated into the scenario framework, the community *a priori* judge such scenarios as implausible. This results in these approaches to remain marginalised both in research and in public discourse, inhibiting thus social change and letting them appear as even more implausible to the scientist and so on.

This said, some would argue that options, *to be even researched*, should at least be plausible enough. That is diversity is a relevant criterion to be tracked, but it becomes useless if it permits any scenario to enter scientific research, especially to be taken seriously for policy purposes. There are at least two lines of evidence that speaks in favour of the plausibility of post-growth approaches. First AR6 WGIII authors judged postgrowth scenarios as having some plausibility: "scenarios outside the range [of current five reasons SSPs] have *some plausibility* – including the option of *economic decline*" (My emphasis, Riahi et al. 2022, p.24). Integrating them into the scenario framework could thus provide a way to further assess how plausible these options are. Second, recent research from both growth and post-growth-oriented scholars, has raised doubts concerning the plausibility or feasibility of ambitious mitigation scenarios based on the SSP framework with GEGA satisfied, i.e. scenarios 2(a) and 2(b) in the argument in section 4 (e.g., Brutschin et al., 2021; Riahi et al., 2022, Li et al., 2023, Engels et al. 2023). Hence different approaches should be considered, and relaxing GEGA seems like the natural move.

7. Conclusion: a call for a post-growth turn

Current mitigation pledges and options are insufficient to effectively tackle climate change. Mainstream IA modelers are not seriously considering all options, aligning most of their value-laden research to the Global North political growth-oriented values. Things need not be that way and scientists have the duty to explore a more diverse set of options. This paper should be read as yet another interdisciplinary call for the IAM community to start exploring more seriously a *post-growth turn*. This seems to require two things. First, at the theoretical level one needs to integrate post-growth into the scenario framework, by developing post-growth compatible SSP and IAMs, as argued in section 4. This is crucial to facilitate further explorations of this turn and assess its plausibility/feasibility across dimensions (Brutschin et al., 2021). Some recognition of post-growth comes from within the IAM community (for e.g. Van Vuurren et al. 2018, Kikstra et al. 2024, and even arguably Grubler et al. 2018[9] Low Energy Demand LED scenario). This is still shy, seeing the urgency to act. Second, a practical precondition for this theoretical turn is more research funding and projects. Global North's funded projects on post-growth are flourishing here and there with several interesting results – as attested by the number of recent publications, the references in this paper are but a sample –, and more to come. To date several ERC and EU projects are funded, including one 10 million euros Synergy grant (REAL) for Jason Hickel, Giorgos Kallis, and Julia Steinberger. More

[9] LED could be interpreted as a post-growth mitigation scenario if one assumes that decoupling is impossible and that the behavioural changes and policies of LED inevitably lead GDP to degrow (Hickel 2019). However, no calculation of GDP was performed by Grubler and colleagues (Keyßer and Lenzen 2021), but they seem to assume that LED is GEGA compatible.

projects coming from the scenario and IAM community are needed. This is essential to bring about a potential political turn, which enhances the political feasibility (Jewel and Cherp, 2020) of post-growth mitigation scenarios.

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