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Economic Growth in mitigation scenarios: A blind spot in climate science

Global scenarios from a growth-critical perspective

KAI KUHNHENN

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Contents

Premises

- Climate change mitigation scenarios are important instruments for developing pathways towards a climate-friendly world. They form the basis for political and social negotiations regarding the climate protection measures to be adopted.
- Unfortunately, current mitigation scenarios follow a path of economic growth because:
    - underlying socioeconomic assumptions assume further economic growth, and
    - the modelling is done with models in which measures that would lead to less production and consumption either cannot be included or are not used due to a limited welfare concept.
- This dismisses the possibility of a fundamental shift towards a society that is not based on economic growth. Policy measures beyond the logic of growth are not included in the debate on climate policy and society as a whole.
- Instead, the scenarios suggest that a temporary «overshooting» of the global warming target of 1.5°C must be accepted, and that this can remedied later with risky geoengineering technologies to remove emissions from the atmosphere.

Therefore, the author of this study and the Heinrich Boell Foundation call on the scientific community to:

- establish research projects that envisage pathways that go beyond the economic growth model and include voices outside the economic mainstream;
- expand the current models and the underlying theory to include growth-inhibiting policy measures as well as to take into account in policy assessments the extent to which they contribute to the satisfaction of various human needs.
- Failing this, model results must be interpreted much more cautiously.
    - Policymakers and civil society actors must insist on these new efforts and support them through research programmes, development funding, and public relations work.

1. Introduction

The results of the Integrated Assessment Models (IAMs) are essential components of reports created by the Intergovernmental Panel on Climate Change (IPCC). Their modelling combines a natural science component and a socio-economic component: The climate science modelling projects the climate change impacts of rising greenhouse gas (GHG) emissions. Along with the components from natural science, however, models also consist of socio-scientific and economic elements – they are used for calculating the most cost-efficient mitigation measures for reaching a specific GHG emissions target, such as complying with the 1.5° or 2°C target.

Distinguishing between the models» natural scientific and socioeconomic components is crucial because, unlike natural scientific components, social components are influenced by modellers» assumptions and political mindsets. There is no «neutral» or «objective» view about how an economy or society functions and how it may or may not develop over the next 80 years.

On the basis of: a) persistently high global GHG emissions; b) the small amount of emissions that remain in the limited GHG budget, which theoretically makes it possible to still limit global warming to 1.5°C; and c) the discount rates used (see excursus below), IPCC reports conclude that:

1. «Conventional» climate protection measures, such as using renewable energy or reducing energy consumption by increasing efficiency, are insufficient. According to the IPCC, most scenarios that meet the 1.5°C limit deploy geoengineering technologies to remove large quantities of CO_2 from the atmosphere. Most frequently used among the so-called carbon dioxide removal (CDR) technologies is a technology termed BECCS: bioenergy with carbon capture and storage. BECCS aims to combine several controversial technologies, from generating energy by burning plant-based raw materials to sequestering the emissions that arise in the combustion process and storing them in geological strata and former oil and gas field reservoirs (thereby removing them from the atmosphere). Alternative CDR proposals include afforestation (often with monocultures), a different type of land management, the direct removal of CO_2 from the air (Direct Air Capture), and «enhanced weathering». All of these schemes bear uncertainties and come with risks for human communities and the natural environment. It is unlikely that they could be used at scale because they are expensive, energy intensive, and/or require huge amounts of land.[1]

1 See European Environment Agency (EEA) (2011), «Opinion of the EEA Scientific Committee on Greenhouse Gas Accounting in Relation to Bioenergy», https://www.eea.europa.eu/about-us/governance/scientific-committee/sc-opinions/opinions-on-scientific-issues/sc-opinion-on-greenhouse-gas

2. Temporary global warming in excess of the global warming targets («overshoot») might need to be tolerated, even if preference is given to scenarios avoiding temperature overshoot due to the risks and potentially irreversible impacts such an overshoot entails.[2]

This short study shows that neither the use of CDR technologies is as indispensable as shown in the scenarios, nor is an overshoot unavoidable. The IPCC conclusions result from models and modelling processes that present only *some* of the possible developments. In contrast, the focus of this study is on economic growth and climate policy measures that envisage less production and consumption.

This is necessary and relevant because all the scenarios considered by the IPCC assume further economic growth, which is a key driver of GHG emissions: As the economy grows, so does the volume of services and products offered and consumed. Production and consumption are inevitably linked to GHG emissions. This is why a growing economy makes it difficult to adhere to ambitious climate change mitigation pathways.[3][4]

By ignoring pathways that do not envisage economic growth, the standard models ignore the possibility (and necessity) of fundamental social change.

2 See IPCC (2018), «Summary for Policymakers», in: *Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C Above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty* [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.)] World Meteorological Organization, Geneva, Switzerland. See also IPCC (2015), *Climate Change 2014: Mitigation of Climate Change – Working Group III Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Summary for Policy Makers*: «Mitigation scenarios reaching about 450 ppm CO_2eq in 2100 typically involve temporary overshoot of atmospheric concentrations, as do many scenarios reaching about 500 ppm to about 550 ppm CO_2eq in 2100. Depending on the level of the overshoot, overshoot scenarios typically rely on the availability and widespread deployment of BECCS and afforestation in the second half of the century.»

3 At this point, it is often added that it is possible to completely decouple economic growth and ecocide, a claim the IPCC itself questions: «There are only a few countries that combine economic growth and decreasing territorial CO_2 emissions over longer periods of time. Such decoupling remains largely atypical, especially when considering consumption-based CO_2 emissions», IPCC (2015), *Climate Change 2014*.

4 The very direct connection between emissions and growth is described in the «Kaya identity» as: global CO_2 emissions from human sources = global population x world GDP/global population x global energy consumption/GDP x global CO_2 emissions/global energy consumption. For empirical evidence of how economic activity influences GHG emissions, see the effects of the financial crisis of 2009.

Critics of growth assume that compliance with climate targets is incompatible with continued economic growth and argue that, from a societal perspective, growth is no longer desirable in industrialised countries.

The following figure shows the individual steps in the scenario process that led to the IPCC's results. In the first step, possible socioeconomic pathways were identified. The scientific community has agreed on five of these pathways: the «Shared Socioeconomic Pathways» (SSPs). In the second step of the process, these pathways were translated into quantitative socioeconomic drivers. In the third step, various emissions reductions scenarios were calculated on the basis of pathways and socioeconomic drivers using IAMs. The bottom section in the figure shows how the three steps of the scenario process could be extended with a potential growth-critical perspective.

Figure 1: A schematic representation of the steps in drafting scenarios that are relevant to the IPCC (author's diagram). For a more detailed description, see Riahi et al. (2017), The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview.

	Step 1	**Step 2**	**Step 3**
Process	Identify possible development paths-creation of SSP	Translate paths into socio-economic drivers	Use IAMs to compile scenarios based on SSP and socio-economic drivers
Results	**SSP** (Shared Socio-economic Pathways): 1. Sustainability 2. Middle of the road 3. Regional Rivalry 4. Inequality 5. Fossil-fueled Development	→ **Socioeconomic Drivers:** – Population growth – Economic Development – Lifestyles – Technology – Natural resources	→ **Climate mitigation scenarios:** – Energy production and use – Land use – GHG emissons – Mitigation costs – …
Gateway for growth-critical thought	Describing development paths with economic contraction	Translating contraction paths into negative economic growth rates	Calculating effects of growth-inhibiting measures

In Section 2 of this study, the first two steps in the scenario process are discussed before the currently used models are analysed in Section 3. Each section includes a presentation of the process, a critique from a growth-critical perspective, and a conclusion.

2. Economic growth as the norm in model calculations

For projections of future GHG emissions levels, the scientific community needs to make assumptions about social factors, which partly depend on global population trends and consumer behaviour. Social institutions and policies, available technologies, and natural resource also influence GHG levels. To ensure comparability of different mitigation scenarios, the scientific community has agreed on a number of consistent[5] pathways that are then translated into socioeconomic drivers. However, the scientific community has so far failed to define any scenarios that do not include economic growth. Why is that?

2.1 Pathways and socioeconomic drivers

In its Special Report on Emissions Scenarios[6] of 2000, the scientific community used four different storylines to develop scenarios for the IPCC. The storylines described different pathways with respect to demographic, social, technological, and natural developments and used these parameters to create scenarios. Since then, the methodology and assumptions of the storylines have come to be seen as outdated, which is why the scientific community initiated a new process in 2006 – this time, outside the IPCC framework.[7]

The new process had a different logic: Instead of first making assumptions about the future and then investigating the GHG emissions they create, it used a «backcasting» approach. It began by defining four future scenarios with different GHG atmospheric concentrations (representative concentration pathways, or RCPs). These ranged from an ambitious 2.6 W/m^2 (watts per square metre – the unit to measure radiative forcing), which leads to global warming between 0.4 and 1.6°C, to one of 8.5 W/m^2, which leads to global warming between 1.4 and 2.6°C.[8] Next, qualitative descriptions of appropriate socioeconomic development trajectories were used to create the SSPs.[9] The process went through many rounds with a multitude of scientists, modelling experts, futurologists, and practitioners from countries of the Global North and South.[10] However, despite this positive opening,

5 Here, «consistency» means that the various assumptions create a coherent picture and do not contradict each other.

6 See https://ipcc.ch/pdf/special-reports/spm/sres-en.pdf

7 Kristie L. Ebi et al. (2013), «A New Scenario Framework for Climate Change Research: Background, Process, and Future Directions».

8 Figures for global warming apply to the period 2046–2065. It is generally assumed that planetary warming above 2°C will have catastrophic consequences.

9 Ebi et al. (2013).

10 Ibid.

the results suggest that few voices outside the economic mainstream of the global North were heard. For example, the literature that came out of this process does not question the concept of economic development and development in general, and it closely associates them with the positively connoted concept of «economic growth».

A total of five socioeconomic development trajectories were developed.[11] The SSPs include «narratives [that] form a set of consistent, qualitative descriptions of future changes in demographics, human development, economy and lifestyle, policies and institutions, technology, and environment and natural resources».[12] They are shown in Table 1. Table 1: The five «Shared Socioeconomic Pathways» with statements on economic growth and calculated average growth rates.

Table 1: The five «Shared Socioeconomic Pathways» with statements on economic growth and calculated average growth rates.

Name of the SSP	**Brief description[13]**	**Statements about economic growth[14]**	**Calculated average economic growth rates between 2010 and 2100[15]**
1 - Sustainability	The world shifts gradually, but pervasively, toward a more sustainable path, emphasizing more inclusive development that respects perceived environmental boundaries.	Beginning with current high-income countries, the emphasis on economic growth shifts toward a broader emphasis on human well-being, even at the expense of somewhat slower economic growth over the longer term.	Industrialised countries: 1.0-1.4% World: 2.1-2.2%
2 - Middle of the road	The world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns.	The world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns.	Industrialised countries: 1.1-1.3% World: 2.0-2.7%

11 These paths were probably also used in the special report on compliance with the 1.5°C limit.

12 D. P. Van Vuuren et al. (2017), «The Shared Socio-economic Pathways: Trajectories for Human Development and Global Environmental Change», *Global Environmental Change* 42, 148–152, https://doi.org/10.1016/j.gloenvcha.2016.10.009

13 Descriptions from Brian C. O»Neill et al. (2017), The roads ahead: narratives for shared socioeconomic pathways describing world futures in the 21st century.

14 Ibid.

15 Results in Marian Leimbach et al. (2017), «Future growth patterns of world regions – a GDP scenario approach», and Jesus Crespo Cuaresma et al. (2016), «Income projections for climate change research: a framework based on human capital dynamics». The survey article, «The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications», also quotes Rob Dellink et al. (2017), «Long-term economic growth projections in the Shared Socioeconomic Pathways» – but growth rates cannot be compared.

Name of the SSP	Brief description[13]	Statements about economic growth[14]	Calculated average economic growth rates between 2010 and 2100[15]
3 - Regional rivalry	A resurgent nationalism, concerns about competitiveness and security, and regional conflicts push countries to increasingly focus on domestic or, at most, regional issues.	Economic development is slow, consumption is material-intensive, and inequalities persist or worsen over time, especially in developing countries.	Industrialised countries: 0.6-1% World: 0.8-1.0%
4 - Inequality	Highly unequal investments in human capital, combined with increasing disparities in economic opportunity and political power, lead to increasing inequalities and stratification both across and within countries.	Economic growth is moderate in industrialized and middle-income countries, while low-income countries lag behind, in many cases struggling to provide adequate access to water, sanitation and health care for the poor.	Industrialised countries: 1.1-1.3% World: 1.1-1.7%
5 – Fossil-fueled development	Driven by the economic success of industrialized and emerging economies, this world places increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development.	All these factors lead to rapid growth of the global economy.	Industrialised countries: 1.6-1.7% World: 2.6-2.8%

Source: Vuuren et al. 2017

To use these development trajectories in computer models, they were translated into quantitative parameters by three scientific teams using neoclassical models.[16] In doing so, the teams adopted their own implicit normative ideas and/or reproduced mainstream assumptions that are dominant in their respective scientific disciplines, ignoring whether perpetual economic growth is desirable – or even possible – in a world with limited resources. The findings merely note: «The adoption of more extreme assumptions (e.g. negative growth rates) either leads to projections with implausible long-term global income levels or requires a highly arbitrary selection process of countries exposed to such extreme assumptions.»[17] This clearly shows that the scientists who develop such scenarios have firm ideas about the future, on the basis of which they assess the scenarios» results and exclude any scenarios that do not correspond to their vision from further analysis. The participating scientists assume that negative growth rates will inevitably have strong negative social impacts – a notion disproved in Section 2.2.1. As for the question about which specific countries might be suitable for abandoning their fixation on economic growth: The

16 Leimbach et al. (2017), «Future Growth Patterns»; Crespo Cuaresma et al. (2016), «Income Projections»; and Dellink et al. (2017), «Long-term Economic Growth Projections».

17 Leimbach et al. (2017), «Future Growth Patterns».

growth-critical perspective should be understood as a framework for industrialised countries, which, due to their high standards of living, do not require economic growth to deliver basic social services, and which, considering equity and climate justice, should pay for their historical emissions (see also Section 2.2.3).

The three scientific teams assume only positive growth rates (see column 4 of Table 1 and Figure 1). For example, Leimbach et al. present annual per capita growth rates between 1% (SSP3) and 2.8% (SSP5). In high-income countries, average GDP per capita is still rising between 0.6% and 2.8% each year.[18] These figures may seem low, but such rates create exponential growth. Even a growth rate of 1% over 80 years means a doubling of economic output, and a growth rate of 2.5% a seven-fold increase.[19]

These calculations are particularly disappointing with respect to SSP1. Although this pathway was explicitly formulated to shift the focus from economic growth to human well-being, only positive growth rates have been calculated – including for industrialised countries. Why was an elaborate qualitative scenario process conducted when there was no ability or will to come up with appropriate socioeconomic assumptions and indicators that actually reflect human well-being rather than gross economic parameters? The failure to envision any social development trajectories aside from a growing economy wastes an important opportunity to map the entire scope of solutions for plausible developments.

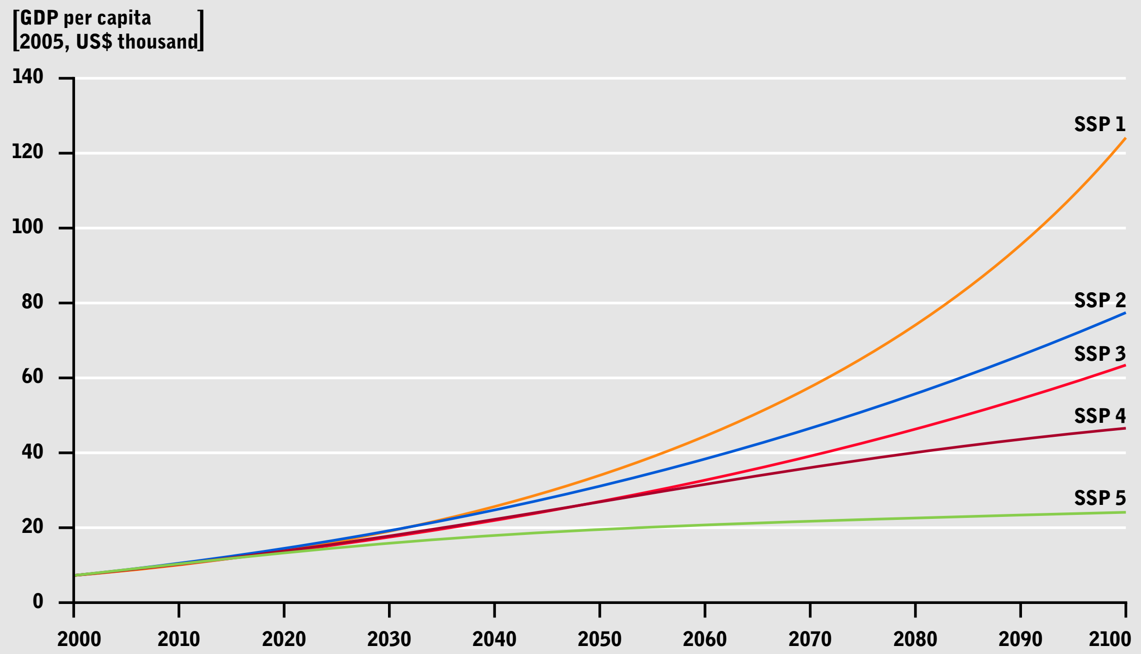
Although the scenario for SSP3 – regional rivalry – has the lowest growth rates, it is also the least socially desirable: It is a trajectory in which inequalities persist or even worsen, especially in developing countries. Resurgent nationalism, regional conflicts, and concerns around security and competitiveness accompany the growing inequalities. This description shows that not every type of economic stagnation or contraction is positive – growth critics have made that point repeatedly and for a long time. Growth-critical concepts are always concerned with shaping social development towards greater ecological sustainability and social justice – developing «by design», not «by disaster» (see also Section 2.2.1).

The pathways, the socioeconomic drivers calculated on their basis, and the various scenarios regarding future GHG atmospheric concentrations, or RCPs, provide the basis for calculating climate change mitigation scenarios. For example, an ambitious, sustainable mitigation scenario can be analysed by combining SSP1 and RCP 2.6, whereas combining SSP2 and RCP 8.5 projects a world that is not changing significantly and is heading towards climate catastrophe. These model calculations reveal which mitigation measures are needed in each case. IAMs are used for these analyses (see Section 3).

18 Leimbach et al. (2017), «Future Growth Patterns»; and Crespo Cuaresma et al. (2016), «Income Projections».

19 With respect to possible decoupling, see footnote 3.

Figure 2: Global GDP per capita up to 2100 in SSP 1-5



Source: Leimbach et al. 2017: «Future growth patterns of world regions – A GDP scenario approach»

2.2 Economic growth as the standard pathway – reasons and reactions

Since economic growth is not a law of nature, why has the scientific community not modelled a single pathway that envisages a no-growth or degrowth trajectory – at least in the «mature» economies of industrialised countries? Where does the unchallenged premise of growth come from? Why should this be discussed, and why does it need to be changed?

2.2.1 Human needs instead of economic indicators

One reason for continuing to insist on economic growth as necessary is because it is still seen as an appropriate indicator of quality of life. However, this assumption receives much criticism, on both theoretical and empirical grounds: Both expenditures that enhance welfare – such as investments in education, and expenditures that decrease it, such as the costs of car accidents – contribute to economic growth. The explanatory power of «economic growth» as such is therefore very limited. On the other hand, there is criticism on the empirical level: Many different studies reveal a very low correlation – if any – between life satisfaction and GDP in industrialised countries.

Germany is a good example of this: Although the economy continues to grow, life satisfaction has stagnated since the 1980s.[20]

Growth critics also argue that the endless pursuit of growth cannot satisfy human needs, and in fact prevents fulfilment of many of them, including:[21]

- the need for leisure in an accelerated world of work that has no bounds;
- the need for meaningful participation when companies are organised in strict hierarchies to maximise efficiency, and states make policy decisions based on market considerations in order to compete internationally; and
- the need for freedom when, in the interest of ensuring national economic growth, trade rules are designed to disadvantage people from the Global South, who are at the same time physically and legally prevented from entering the Global North.

This analysis shows that there must be a transition to a needs-oriented economy that serves people and is «growth critical» in the sense that it does not rule out a no-growth or degrowth trajectory. The aim is not economic depression or austerity, but rather a structured process that leads towards a society with fewer material goods – and less pollution, noise, and stress, as well as more democratic decision-making and time for unpaid care work (e.g. housekeeping, nursing, and childcare).

2.2.2 Sharing the cake instead of increasing its size

Another reason for maintaining a fixation on economic growth is the fear that social systems would collapse without it. The most common line of argument is that technological progress reduces the demand for jobs, which causes tax revenue to drop (less wage tax) and increases the need for social benefits (more jobless people). To counteract this effect, more economic growth is needed to create jobs.

However, this reasoning overlooks numerous design options. Reducing working hours can *also* reduce joblessness. Redesigning the tax system (raising environmental, corporate, and inheritance or wealth taxes) could make up for lost tax revenues from wages and steer technological progress towards increasing environmental efficiency. These changes would, at the same time, open the door to a welfare system that is not based on fear and bullying,

20 See DIW (2015), «SOEP 2013 – SOEP Monitor Individuals 1984-2013 (SOEP v30)», https://www.diw.de/en/diw_01.c.504352.en/soep_v30.html

21 The needs come from the concept developed by Paul Ekins and Manfred Max-Neef in *Real-life Economics* (London: Routledge, 1992).

but on the belief that basic material security is a fundamental right that allows individuals to explore economic and social alternatives.

2.2.3 Countries of the South – making space for autonomous action

Development policymakers often argue that further economic growth is absolutely necessary for countries in the Global South. At this point it should be reiterated that the growth-critical perspective is understood as being applicable for industrialised countries.

Many critics of growth, including those from the Global South,[22] believe that imitating the Western growth model does not lead to positive developments for everyone but to a deepening exclusion of poorer social classes – for example, as a result of the privatisation of public goods such as water, land, natural resources, and transport routes.

A discourse about alternative development models is growing in these countries, along with resistance to the unchecked exploitation of natural resources at the expense of local populations. This is partly based on long-disregarded indigenous experiences, which has a lot to teach to countries of the Global North.[23]

Keeping in mind the need for autonomous development, no recommendations for countries in the Global South should be made here, as this would not even be possible given the diversity of country contexts. Their citizens can best choose their own pathways.[24] Of course, industrialised countries must support them, first by dismantling exploitative structures such as unfair trade rules, land-grabbing, and neoliberal economic policies as a condition for lending. Further support, for example, by financial means, transfer of know-how, and capacity-building, has been repeatedly demanded by governments of the South and been successfully integrated into various treaties under the UN Framework Convention on Climate Change – most recently in the Paris Agreement. However, the funds made available lag far behind the obligations. Demanding this support is fully justified, since industrialised countries have used up the development space of countries of the Global South to such

22 See Alberto Acosta (2016), «Rethinking the World from the Perspective of Buen Vivir» in *Degrowth in Bewegung(en)*, (https://www.degrowth.info/en/dim/degrowth-in-movements/buen-vivir/) and the section «Südperspektiven – Am Wachstum hängt, zum Wachstum drängt ...?» in the brochure *Darf's ein bisschen mehr sein?* (https://www.brot-fuer-die-welt.de/fileadmin/mediapool/2_Downloads/Sonstiges/ein-bisschen-mehr.pdf).

23 Pablo Solón's «Systemwandel Alternativen zum globalen Kapitalismus» of 2018 presents a good overview of the South's discourse on alternative development models.

24 A large percentage of people surviving below the poverty line are not in the Global South but rather in industrialised countries and emerging economies. In light of how unequally the profits of growth are distributed, equitable redistribution seems to be a better solution than economic growth.

an extent that they are denied the pathway of the countries from the Global North if they do not want to jeopardise the natural basis of life any further.

2.2.4 Jump-starting discussions about a world without growth

Finally, since it is still argued that scenarios that do not include economic growth are unrealistic, it must be asked which development trajectories are realistic – why, and who decides on plausibility?

The SSPs have been designed in order to «provide a description of plausible human development strategies that lead to very different future challenges…»[25] The question of what «plausible development strategies» consist of is shaped by currently prevailing patterns of thought. Relatively new concepts in human history – such as the pursuit of growth, open markets, global trade, and economic development – are unquestioned components of today's global economy, and will probably remain so for the next five to ten years. However, the SSPs and the mitigation scenarios based on them use a time horizon of 2100. This 80-year span allows for far more profound socio-economic changes than have been described so far in the SSPs. Given that the development pathways currently being pursued undermine the natural basis of human life, continuing them that far into the future is dangerous and short-sighted. Against this background, fundamental social change must be promoted and demanded.

In light of economic history and our knowledge of various recent and historical alternatives to a growth-based society, it can legitimately be assumed that humanity can reject the drive for perpetual economic growth – and in fact should, given the explanations in Section 2.1.1. Socio-economic pathways developed for emissions reductions must reflect this possibility so that the climate policy debate can be expanded to include discussions about how a modern, growth-independent society can function, what that means for different social groups, and how to get there.

This should, however, not be used to pretty up emissions reductions scenarios by relying on economic shrinkage or stagnation in order to reduce environmental destruction. On the contrary, zero-growth scenarios must clearly explain that such a development can only lead to a positive outcome when underpinned by fundamental social change, including redistributive policies towards reduced social inequality. This vision cannot be achieved through individual renunciation but rather through a radical change in social, economic, and cultural structures.

25 Van Vuuren et al. (2017), «The Shared Socio-economic Pathways».

Starting points for this are:

- reducing working hours (and compensating wages) in order to create space for leisure and social participation;
- upgrading care and nursing activities, and creating jobs outside of energy and resource-intensive industries;
- supporting the non-profit cooperative sector through subsidies, tax exemptions, and legislation; and
- developing top-notch and affordable public transport systems to meet mobility needs while at the same time changing the incentive structures for using private cars.

A prerequisite for many of these measures is the redistribution of income, wealth, and work.

Excursus: Scenarios without «negative emissions»?

Given the risks and uncertainties of CDR technologies that many scenarios rely on for so-called «negative emissions», several studies have investigated how we can limit global warming to 1.5°C without large-scale deployment of risky geoengineering technologies.

Grubler et al. (2018)[26] *focus on reducing energy consumption through «rapid social and institutional changes in how energy services are provided and consumed, in addition to technological innovation».*[27] *Aside from stagnation in the demand for living space per person, this scenario also envisages an increase in the consumption of energy services, which is more than offset by social innovations such as car-sharing, but above all through increased efficiency.*

26 «A low energy demand scenario for meeting the 1.5°C target and sustainable development goals without negative emission technologies.»

27 Ibid.

Holz et al. (2018)[28] *investigate how much emissions will have to be cut if the deployment of CDR technologies is strictly limited or eliminated entirely in the models. They conclude: «Where societies choose to proceed with cautious assumptions about the scale and availability of CDR, they will have to investigate rates of CO_2 reductions well outside of what is currently deemed plausible.» Their modelling shows that models for abandoning CDR technologies inevitably challenge assumptions about population and economic growth and non-CO_2 GHGs, such as methane and nitrogen compounds from agriculture.*

Van Vuuren et al. (2018)[29] *base their scenario on SSP2 and examine a number of mitigation measures and their combinations in order to reduce the amount of «negative emissions» required to reach 1.5°C. Measures include global carbon taxes from 2020, faster expansion of renewable energies, a smaller global population, and lifestyle changes (less meat consumption and heating/cooling, sustainable mobility). They discover that, although these measures sharply reduce the need for «negative emissions», they cannot eliminate them.*

What these studies have in common is that, although some adopt measures that have growth-dampening effects, they do not question continued economic growth per se. However, the scenarios that envisage a significant reduction in energy consumption through efficiency and isolated behavioural changes are of particular interest.

It remains to be studied and modelled how much energy consumption could be reduced by targeting emission-intensive industrial sectors that contribute little to meeting human needs, or are in fact detrimental to it. These include the defence industry, industrial meat production, the production of (high-engine) passenger cars, freight transport, business aviation, etc.

2.3 Conclusion 1 – New pathways must be explored

In modelling global scenarios up to 2100 that would describe all plausible pathways, the scientific community faced a difficult task. To accomplish that, in the first step they created pathways (SSPs) through a complex process that goes far beyond earlier methodology. In a second step, the pathways were translated into model-based quantitative targets.

While the scientific community opened up during that first step, it seems that still no voices outside of the (economic) scientific mainstream – who could conceive of totally new

28 «Ratcheting ambition to limit warming to 1.5°C – trade-offs between emission reductions and carbon dioxide removal.»

29 «Alternative pathways to the 1.5°C target reduce the need for negative emission technologies.»

solutions – were included: Scholars of the Global North continue to dominate the discussion with their notions of capitalist modernity. These include the idea that not only «under-developed» countries need economic growth to «develop», but that economic growth is also required to ensure stable societies in «developed countries». Such views strongly influenced the second step of the process, in which supposedly «objective» neoclassical economic models were used to translate the development trajectories into quantitative parameters, thereby further restricting the scope of possible pathways.

This restriction has consequences. The models» ambitious GHG emissions targets become harder and harder to reach, or are only achievable with a temporary overshoot and so-called «negative emissions». The scientific community has fallen victim to the «danger of a single story».[30] In order to include other stories and enlarge the space of legitimate solutions, voices from outside the scientific community of the Global North must be heard. Many of these can be found in the Global South and among the many civil society groups and social movements in the Global North.

These actors» solutions may sound utopian, but 2100 is too distant to regard the current economic, cultural, and social structures as being unchangeable. On the contrary, assuming that the economy will continue to grow until the end of the century is indeed unrealistic because economic growth is destroying the very (natural) foundations on which life is based. Developing alternatives to this is not utopian, but radically realistic!

The scientific community must set up research projects that are not content with the current definition of «plausible pathways» but which seek a future that enables a good life for all. They need to listen to voices outside the economic mainstream, and politics and civil society must support the projects through research programmes, funding, and public relations work.

30 See Chimamanda Ngozi Adichie, «The Danger of a Single Story», https://www.ted.com/talks/chimamanda_adichie_the_danger_of_a_single_story

3. Are economic growth and models inseparable?

As described above, growth-critical perspectives were not included in the definition of SSPs. However, there is another possible gateway for growth-critical thought: When running mitigation scenarios, models could conclude that, in addition to expanding renewable energies and boosting energy efficiency, economic activity must be reduced in order to limit global warming to 1.5°C. The following sections explain why this is not happening.

3.1 How the models work

To determine the mitigation measures required to reach a particular goal, climate scientists rely on IAMs, as described earlier.[31] These models look for ways of reaching specific emission-reduction targets, often using utility or welfare functions that, based on dominant economic theories, are designed to maximise material well-being.

As a well-documented example, the utility or welfare function of the REMIND model[32] for one geographical area and one year reads as:

overall utility = ln (consumption[33]/number of people) x number of people[34]

According to this function, for overall utility to rise, the number of people and/or the amount of their consumption has to increase. The logarithm function ensures that the overall benefit of an increase in consumption depends on the original level of consumption: Gains in consumption in materially poor societies increase the overall benefit more than in rich ones.

The overall benefit is then added across all geographic areas and years. This sum is optimised, that is, maximised by the model. At the same time, the models have specific boundary conditions, such as compliance with a particular emissions budget. This creates a

31 The scenarios relevant to the IPCC are calculated using the following six models: AIM-CGE (IIASA, Austria), GCAM (JGCRI, USA), IMAGE (PBL, Netherlands), MESSAGE-GLOBIOM (IIASA, Austria), Remind MagPie (PIK, Germany), WITCH-GLOBIOM (FEEM and cmcc, Italy). K. Riahi et al. (2017), «The Shared Socioeconomic Pathways».

32 The REMIND model was developed by a major research institute, the Potsdam Institute for Climate Impact Research, and is well documented.

33 It should be borne in mind that «consumption» has a special significance here that is linked to a large number of assumptions.

34 The equation does not include any discount factor. See the excursus below.

dilemma for modellers: On the one hand, greater economic activity (heating, driving cars, industrial production, etc.) is necessary to increase consumption; on the other, this economic activity is also the main driver of GHG emissions, and thus of global warming. The modellers try to resolve this contradiction by

1. adopting measures to reduce the amount of energy used in economic activities, for example through more efficient production methods or more efficient products;
2. using other forms of energy, such as renewables, that emit fewer GHGs[35]; and
3. assuming carbon dioxide is removed from the atmosphere at large scales («negative emissions» through CDR).

How is a particular option selected for in the models, and to what extent? This depends on the cost of the various options and how they impact the utility function.[36] This can be illustrated by the marginal avoidance cost curve (Figure 3),[37] in which mitigation measures are sorted from left to right according to the costs per tonne of CO_2 saved. The width of the measures indicates the amount of GHG emissions that can be saved by the measures. First, the models choose the measures at the left, which cost the least or may even be associated with economic gains. Depending on how many GHG emissions have to be saved, more and more of the measures further to the right are deployed. In conclusion, the lowest-cost measures[38] are used first. The assignment of costs for individual mitigation measures is problematic because a) many social and environmental costs are excluded, and b) there is no (societal) debate about the pros and cons of the measures. The way IAMs make decisions on the desirability of certain mitigation options are therefore not necessarily consistent with societal preferences or socially and environmentally desirable outcomes.

In a nutshell, the model is fed the assumptions of the pathways and the socioeconomic drivers derived from them. It produces utility-optimised scenarios that describe which mitigation measures must be implemented to which extent and at which speed, and which social costs they entail (see Figure 1).[39]

35 Unfortunately, the use of bioenergy is projected in many models at levels that are far from being environmentally sustainable as well as socially just in many cases.

36 Which measures are used in which scenario (and which are not) is rarely presented transparently, which makes it more difficult to discuss which measures are socially desirable.

37 Most IAMs do not work with static marginal abatement cost graphs, but rather calculate the costs of climate protection measures at any moment on the basis of investment and operating costs, efficiency, etc. That is, they work

38 These macroeconomic costs exclude many environmental costs.

39 Economic growth is both an input parameter and a result of the model. Thus, if mitigation measures strongly influence economic growth, they may produce inconsistent scenarios.

3.2 Why models know no «less»

If less production and consumption reduce GHG emissions, why are these appropriate measures not included in the models? The following two sections study this problem.

3.2.1 A limited portfolio of measures…

The question of which mitigation options are chosen by the models and to what extent depends on the measures the models have at their disposal and the assumptions made about their costs.

Traditionally, technological measures on the energy supply side are well represented in IAMs. In contrast, those on the demand side are much less developed. One reason for this is that it is much easier to find cost estimates for expanding renewable energies or operating more efficient gas-fired power plants than for technical-efficiency measures such as refurbishing buildings, manufacturing more efficient cars, and replacing light bulbs.

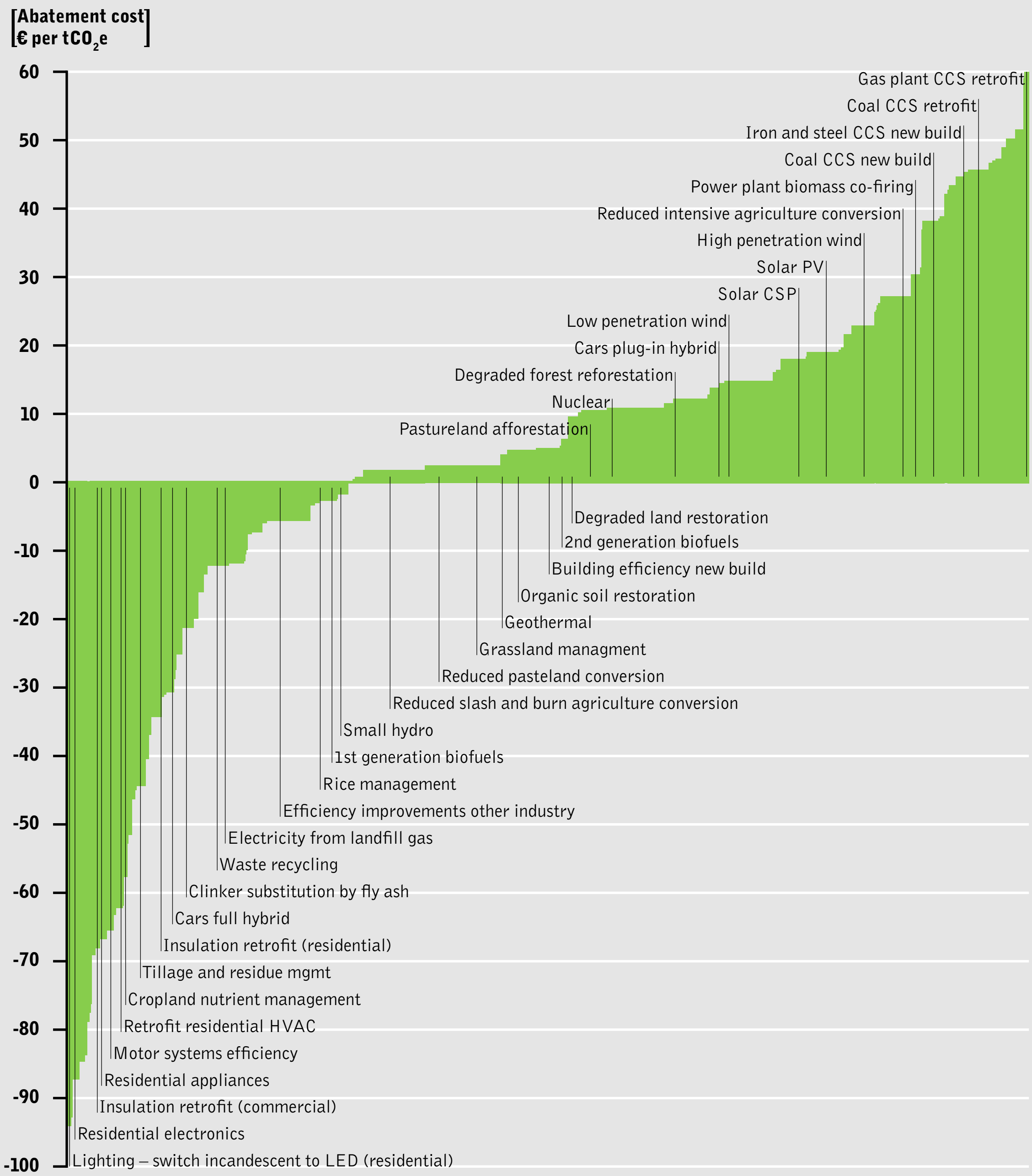
Integrating measures that do not primarily describe technological change but rather behavioural changes is even harder. Calculating the potential social costs of switching to car-sharing, not eating meat, introducing longer product cycles, and banning advertisement is methodologically challenging.

However, this should not be used to justify ignoring these options as relevant mitigation options – as has been done so far – because compared with many (large-scale) technological measures, they lead to less environmental destruction, help dovetail ecological and social issues, and thus offer a vision of how a good life for everyone within ecological limits might be possible.

The models» emphasis on technological solutions relates to the debate about society's relationship to nature. Writers such as Ulrich Beck,[40] for example, maintain that the notion that people can control, calculate, and harness nature leads to technological problems and dangers for humanity. Reacting with more technological fixes only serves to create more and more related problems. The fact that GHG emissions continue to rise despite 30 years of efforts to protect the environment confirms this thesis.

40 Ulrich Beck, *Risikogesellschaft – Auf dem Weg in eine andere Moderne* (Suhrkamp, 2015).

Figure 3: Cost curve for avoiding greenhouse gases (Worldwide, 2010)



Source: Global GHG Abatement Cost Curve v2.0, own chart

What is needed is thus a relationship to nature that is not defined by exploitation and control. Extensive debates (see e.g. Görg[41], Latour,[42] and Descola[43]) emphasise that our relationship with nature is entangled with other forms of social exclusion and exploitation. They suggest that changing our relationship with nature and practicing self-sufficiency can be part of a complete socio-ecological transformation.[44]

3.2.2 ...that considers only material well-being

As shown above, the models are designed to maximise income and consumption per person. These specifications decide how the model evaluates mitigation measures – based only on how they impact personal income and consumption.

Such assumptions run counter to the growth-critical perspective that a fairer, more ecological and contented society requires less production and consumption. The models never select measures such as lower amounts of traffic, living space per person, working time, advertising, etc., as options as long as technological measures exist that are assumed to be cheaper. That growth-inhibiting measures produce significant *gains* – more leisure time, less noise and pollution, a healthier environment, etc. – is ignored, as are the costs of risky (geoengineering) technologies.

The utility or welfare function assumes that an individual is only concerned with material consumption. The model does not show that this consumption has other «costs» – the destruction of natural resources, quality of life, social relationships – and creates a dog-eat-dog mentality. To properly assess climate change mitigation strategies and measures, models that integrate the variety of human needs and the benefits of an intact environment are needed.

41 Christoph Görg, *Nichtidentität und Kritik – Zum Problem der Gestaltung der Gesellschaftlichen Naturverhältnisse* (in *Kritische Theorie der Technik und der Natur*, Böhme & Manzei (eds.), Paderborn, 2003)

42 Bruno Latour, *Das Parlament der Dinge*, (Suhrkamp, 2001)

43 Philippe Descola, *Jenseits von Natur und Kultur*, (Suhrkamp, 2011)

44 These debates are also about technological innovations: how to make technology more social, so that it destroys less (see, e.g., Vetter, Andrea 2017: *The Matrix of Convivial Technology – Assessing technologies for degrowth*, Journal of Cleaner Production, Volume 197, Part 2, 1 October 2018, Pages 1778-1786)

Excursus – When should the climate be saved? The discount rate

The IAMs described above are not only used to figure out which mitigation measures should be employed, but also at what point in time. They do this by comparing their costs and benefits.

Many mitigation measures – especially technological ones – are based on investments, such as the construction of a photovoltaic system, that bring benefits over time. A discount rate (i.e. a percentage number by which costs and benefits in the future are devalued) is used to compare costs and benefits at different times. Economists often regard this rate as empirically justified because every person values a present benefit more than the same benefit in the distant future. The discount rate is also in line with current economic logic, which considers that €1,000 in the present is preferable to €1,000 in the future, because money that is invested (usually) earns interest. This line of reasoning results in a discount rate of about 5 per cent – the rate used in many models.

However, since the models consider very long periods of time, the assumption has dramatic effects: An annual discount rate of 5 per cent means that a loss of €1,000 in 50 years is equivalent to losing less than €80 in the present. From an ethical-normative point of view, this is highly problematic, since it discounts the impacts of future climate change: The costs of climate change for future generations are of less concern than the mitigation investment costs today. Discounting climate change effects is ethically and normatively problematic because it gives less consideration to how much climate change will cost future generations than to the cost of investing in climate protection now.

The models postpone mitigation measures to a time in the (distant) future and often conclude that it is better to first have an overshoot – to exceed the GHG emissions limit – and then offset the surplus in the future by using (allegedly cheap) CDR technologies (that do not even exist today). This is a very risky strategy. Firstly, many self-reinforcing effects of climate change could make it impossible to reduce the temperature after an overshoot. Secondly, the technologies for removing large amounts of GHGs from the atmosphere come with large-scale risks and potentially adverse impacts on communities and global ecosystems. Therefore – and for reasons of «intergenerational justice» – scenarios with a low discount rate, or a rate of zero, should at least accompany others.[45]

45 See, e.g., Richard Rosen (2018), «Should We Discount the Future of Climate Change?» (http://klima-der-gerechtigkeit.de/2018/02/27/should-we-discount-the-future-of-climate-change/), and Lawrence Goulder and Roberton Williams III (2012), «The Choice of Discount Rate for Climate Change Policy Evaluation», (https://www.nber.org/papers/w18301).

3.3 Conclusion 2 – The models must be further developed

The use of models is indispensable in order to illustrate the highly complex relationships of scientific and social systems. However, the current IAMs are not value-neutral, and their normative elements are neither disclosed nor discussed in public.

Particularly deserving of criticism are a) the way the models – optimistically – overemphasise the possibilities of technological change, and b) the use of utility functions that reduce human needs to material consumption. The result is that growth-inhibiting measures are disregarded.

Research should focus on these points of criticism, and policymakers and civil society should be aware of them. As long as these are not addressed, the current models have limited validity: Instead of offering the optimal solution, they offer the (seemingly) cheapest one – assuming a limited set of measures and negating societal change.

It is incumbent on the scientific modelling community to respond to this criticism. It must expand the current models and the underlying theory to include measures that inhibit growth. In addition, assessments of mitigation measures must take into account how they contribute to satisfying diverse human needs and protecting natural ecosystems and resources.[46] Failing this, model results must be interpreted much more cautiously than they are now.

46 Ottmar Edenhofer and Martin Kowarsch (2015) propose a new model for evaluating climate protection measures, in which the scientific community takes the role of cartographers who discuss possible solutions and their consequences with the public («Cartography of Pathways: A New Model for Environmental Policy Assessments», https://doi.org/10.1016/j.envsci.2015.03.017).

The Author

Kai Kuhnhenn has been working for five years at Neue Ökonomie e.V. Previously, he worked for more than eight years at the Federal Environment Agency on policy scenarios, a sufficiency project and the IPCC reports.

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Editor: Heinrich-Böll-Stiftung e.V., Schumannstraße 8, 10117 Berlin
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