



## ANALYSIS

## Accounting matters: Revisiting claims of decoupling and genuine green growth in Nordic countries

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## ABSTRACT

Ecological modernisation in the form of support to the notion of green growth remains the dominant discourse in environmental policy globally. Still, questions of limits to economic expansion and growth on a planet with finite natural resources have been at the core of environmental discourses at least since the 1970's. A recent effort by [Stoknes and Rockström \(2018\)](#) seeks to unite notions of ecological limits with the concept of green growth by proposing genuine green growth as denoting a situation when growth respects planetary boundaries. Focusing on recent trajectories in emissions intensity, they highlight Nordic countries including Denmark as examples of such genuine green growth. In this article, we demonstrate that the specific conceptualization of genuine green growth and resulting claims about the Nordic countries rest on particular assumptions, specifically concerning national-level carbon accounting frameworks and the size of the remaining global carbon budget. By opening up these assumptions for analysis we illustrate the partiality and potentially misleading nature of the conceptualization of GGG.

## 1. Introduction

Recent years have seen a resurgence of the canonical debate on the role of ecological limits accentuated by the unfolding global climate and environmental crises. Even more recently, debates on the need for post-COVID recovery packages to strike a balance between ecology and economy have surfaced ([Hepburn et al., 2020](#)). Some see green growth as 'the sustainable way out of the corona crisis' ([State of Green, 2020](#)). Yet, while intuitively appealing, the notion of green growth is notoriously vague and elusive<sup>1</sup> ([Stoknes and Rockström, 2018](#)).

If green growth is indeed supposed to be a 'way out', what does such a way entail? How can green growth be specified, operationalized and translated into policy goals? These questions matter not least because the rhetoric of green growth appears to exist unproblematically alongside ever more dire scientific evidence and warnings about the multi-

faceted global ecological crisis ([IPBES, 2019](#); [IPCC, 2018](#)). As such, it is perhaps not surprising that activists and scholars call for approaches that clearly put ecological concerns and welfare before growth to guide post-COVID trajectories ([Taherzadeh, 2021](#); [Barlow et al., 2020](#)).

Typically, claims of green growth are assessed by considering decoupling rates ([Wiedenhofer et al., 2020](#)). In the context of climate change, green growth should arguably be judged with reference to decoupling that is both absolute and sufficient for meeting the Paris climate accord goal of limiting the increase in global temperature to 'well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels'<sup>2</sup> ([UNFCCC, 2015](#)). Here, recent and comprehensive reviews of the literature demonstrate that observed decoupling rates fall short with no absolute decoupling at the global level and no national-level examples of the decoupling required to meet climate targets without reliance on

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E-mail address: [Joachim.tilsted@miljo.lth.se](mailto:Joachim.tilsted@miljo.lth.se) (J.P. Tilsted).<sup>1</sup> Ironically, the notion of growth itself is also not clear-cut, as illustrated by the long and contested history of the concept ([Schmelzer, 2016](#)). The difficulties alone in measuring growth in the Gross Domestic Product (GDP) points to a degree of 'fuzziness' surrounding the concept ([Fix et al., 2019](#); [Watanabe et al., 2018](#)).<sup>2</sup> Although we focus mainly on GHG emissions in this article, judging green growth solely in reference to climate change misses the multi-dimensional aspects of ecological concerns (notwithstanding their interrelatedness). We therefore return to such considerations in the discussion.

massive, and in many peoples' eyes risky and unproven, upscaling of negative emissions technologies (Haberl et al., 2020; Hickel and Kallis, 2020). However, debates continue about whether some nations demonstrate green growth trajectories. In this article, we engage in such debates by offering a critical assessment demonstrating how claims of green growth depend crucially on national-level emission accounting frameworks. Specifically, we start from Stoknes and Rockström's conceptualization of Genuine Green Growth (GGG). Focusing on the Nordic countries using the case of Denmark as a primary example, we demonstrate how not only the choice between production and consumption-based accounting frameworks (as is typically stressed) but also choices within production-based approaches alter claims of green growth. Additionally, we show that aiming for limiting temperature the global temperature increase to 1.5 °C demands historically unprecedented rates of decarbonization for Nordic countries even when focusing on territorial emissions and relying on the least precautionary estimates of the remaining carbon budget. The argument highlights that Denmark is not an example of GGG and that strict absolute reduction targets needs to be complemented with considerations of which and how greenhouse gas (GHG) emissions are accounted for. Thereby, we illustrate the implicit assumptions that contribute to the continued celebration of Nordic countries as climate policy frontrunners and examples of green growth.

The article is structured as follows. First, we briefly introduce the GGG concept and situate it within the literature. Second, we use the example of Denmark and other countries in the Nordics to illustrate the limitations of the GGG concept relating to different carbon accounting frameworks and different climate policy targets. Third, before concluding, we discussing a range of other concerns and relevant aspects in relation to setting targets for (genuine) green growth.

## 2. Ecological modernization as genuine green growth

Ecological modernization is the arguably most dominant approach to environmental and climate change policy globally (Christoff, 1996; Dryzek, 2017; Hajer, 1995; Mol and Spaargaren, 2000). It comes in the form of support to the notion of green growth (Obama, 2017), based on the premise that ecology and economy are not fundamentally at odds. Opposingly, the ecological economic and degrowth literature (Kallis et al., 2018; Petridis et al., 2015; Weiss and Cattaneo, 2017) stresses the tension between ecological damage and economic expansion and therefore emphasizes notions of sufficiency (Hickel, 2019; Kallis, 2018; Pirgmaier and Steinberger, 2019; Röpke, 2005). Some critics go on to argue that promises of green growth risk being nothing but a 'rhetorical rescue operation for a capitalist political economy confounded by ecological crisis' (Dryzek, 2017, p. 178), i.e. that the notion of a green economy is an oxymoron (Brand, 2012).

Recognizing that 'green growth'<sup>3</sup> in practice can be a matter of 'greenwashing',<sup>4</sup> Stoknes and Rockström (2018, p. 42) suggest that 'the global economy possibly requires a stronger, i.e. genuine version of green growth to take planetary boundaries (Rockström et al., 2009) fully into account'. If countries can live up to the criterion of GGG, Stoknes and Rockström hold that the 'win-win growth frame', or the narrative of ecological modernisation, remains 'valid' (Stoknes and Rockström, 2018, p. 42).

<sup>3</sup> Formally defined as,  $\Delta RP > \Delta GDP$ , where resource-productivity,  $\Delta RP$ , is the year-on-year percent change in real GDP/environmental resource use. The given resource can be operationalized using relevant indicators that relate to planetary boundaries as for example GHG emissions.

<sup>4</sup> 'Greenwashing' as a concept is often used in relation to corporate marketing practices (see e.g. Parguel et al. (2011)). Stoknes and Rockström, however, apply it at the national level referring to 'talking about reducing climate emissions and other environmental impacts, while simultaneously pushing for as much conventional economic and job growth as possible [italics in original]' (p. 42).

To operationalize GGG, Stoknes and Rockström (2018) focus on climate change 'due to its relative ease of measurement, as well as the urgency of further climate disruptions that would also severely worsen other environmental and social impacts' (p. 42–43).<sup>5</sup> Specifically, they define GGG as a minimum target level for carbon productivity (CAPRO) of a given economic entity (such as nations), understood as real value added/tons of CO<sub>2</sub> (the inverse of carbon intensity<sup>6</sup>); a target by which nations supposedly stay within the planetary boundary for climate change. This minimum target level for CAPRO is found using two approaches. First, Stoknes and Rockström build on the estimated remaining carbon budget in 2015 of 600–1200GtCO<sub>2</sub> for staying below 2 °C with >66% probability (Rogelj et al., 2016). Relying on the higher end of the estimated range, limiting warming to 2 °C requires global reductions of >2% per year from 2015 onwards, i.e. a halving of CO<sub>2</sub> emissions between 2015 and 2050. Assuming annual global GDP growth of around 3% per year, CAPRO needs to increase by more than 5% a year (Stoknes and Rockström, 2018, p. 43). Second, Stoknes and Rockström review literature that quantifies the needed yearly decreases in carbon intensity to stay below 2 °C with estimates ranging from 4 to 11% (p. 44). Taken together, they hold GGG can be defined as:

$$\Delta CAPRO > 5\% \tag{1}$$

Stoknes and Rockström describe the 5% target as 'an optimistic, minimum rate' (p. 43).

## 3. Exploring claims of green growth

### 3.1. The role of carbon accounting

To evaluate claims of GGG by considering carbon productivity, two metrics are needed namely value added (at the national level here given by GDP<sup>7</sup>) and national emissions. National emissions, however, can be accounted for and allocated to jurisdictions according to different frameworks and principles, capturing different dimensions of GHG emitting activities. Important dividing lines are those of footprint vs. emitter-based<sup>8</sup> and geographical vs. economic approaches (Peters and Hertwich, 2008) (see Table 1). While the geographic approach corre-

**Table 1**  
Simplified overview of approaches to national-level GHG accounting.

	Geographic	Economic
Emitter-based	Territorial/domestic emissions	Production-based emissions
Footprint-based	Consumption-based	

Source: Authors' own compilation based on Peters and Hertwich, (2008).

Note: There might be a difference in geographic and economic approaches to footprint-based accounting from e.g. non-residents consuming while in Denmark. However, such discrepancies are likely to be small and are thus not relevant for the article at hand.

<sup>5</sup> In addition to GHG emissions, Stoknes and Rockström mention the need for other environmental indicators for biodiversity, land, water, pollutants and chemical entities as well as nutrient loading.

<sup>6</sup> Stoknes and Rockström (2018) apply CAPRO over carbon intensity mainly for psychological reasons, arguing that this maintains emissions reductions as a gain or an 'up' issue (p. 47).

<sup>7</sup> It should be kept in mind that GDP is an indisputably problematic metric (see Schmelzer (2016) and references therein) which, for example, is argued to not capture certain value-added activities while recording rent-seeking and speculative activities as productive (Mazzucato, 2018; Mazzucato and Shipman, 2014)

<sup>8</sup> Although various combinations of production-based and consumption-based national GHG inventories are possible (Peters and Hertwich, 2008), we focus on these two main frameworks.

sponds to the domestic or territorial approach in the UNFCCC framework, i.e. ‘the amount of carbon embodied in the vector of goods produced on a nation's territory’ (Aichele and Felbermayr, 2012, p. 336), the economic approach is in accordance with national economic accounts. Because some emissions attributable to ‘resident institutional units’ occur outside a nation's territory, such as emissions from fishing vessels or international transport, differences arise (Peters and Hertwich, 2008, p. 54). In that sense, the economic approach to emitter-based emissions includes but extends beyond territorial emissions, which treats the combustion of fuels used in international shipping and aviation (bunker fuels) as separate. This exemplifies how national-level emissions accounting is not only a matter of how to ‘slice the pie’ (attributing global emissions) but also a question of what counts as the pie in the first place (e.g., including or excluding emissions from shipping in international waters). To avoid confusion, we refer to the geographic approach to emitter-based emissions as territorial or domestic emissions while using the term production-based emissions to refer to GHG emissions from resident institutional units (the economic approach) (in line with Wood et al. (2019)). In contrast to emitter-based approaches, consumption-based emissions of any political economy refers ‘to the flow of [GHG] emissions caused by domestic absorption (i.e., consumption and investment) activities’ (Aichele and Felbermayr, 2012, p. 336).

Generally, the question of accounting relates to questions of responsibility (Lövbrand and Stripple, 2011). What (the scope of GHGs) is attributable to who (the unit of analysis)? Production-based approaches implicitly places the responsibility of emissions on the political authority in that territory, treating nation-states as ‘the agents of global warming’ (Lohmann, 2009, p. 501), whereas the consumption-based approach indicates that consumption rather than production causes emissions (Liu, 2015), hence pointing to lifestyle and wealth (and away from producer corporations and economies). So which approach to use in the evaluation of GGG?

Consumption-based accounting has the merit of illustrating the material dimension of increasing material welfare irrespective of where production takes place. While production-based accounts can reflect labor opportunities and monetary flows that are associated with welfare, production-based approaches suffers from issues of generalizability. To illustrate with the help of a stylized example: specialising in financial services or software production can create value added without direct GHG emissions involved in the process. Yet, this hardly reflects green growth, as this specialization cannot be extended to the rest of the world, as the production underlying material welfare (food, housing, etc.) has to take place somewhere. Therefore, consumption-based accounting arguably reflects better who benefits from the pollution-causing production. Indeed, a society that demonstrates GGG with consumption-based emissions has genuinely decoupled emissions from the reproduction of human welfare, and is an example that could be emulated.

From the perspective of unequal ecological exchange (see Dorninger et al. (2021) and references therein), the merits of the consumption-based framework stand out, by reflecting how citizens in the Global North take up a disproportional share of the environmental space (in form of the global carbon budget). In this way, footprint-based measures highlight the ability for core countries (cf. dependency theory (Kvan-graven, 2020)) to distance themselves from environmental degradation (as focusing on what takes place within confined areas otherwise neglects). Additionally, Peters and Hertwich (2008) put forward a number of arguments of more technical character for using consumption-based perspectives (p. 57–59). These include (1) solving allocation issues for international activity (presently not a part of national inventories under the UNFCCC as noted above), (2) addressing various forms of carbon leakage (3) adapting GHG reduction targets for developing countries, (4) allowing for environmental comparative advantage and address competitiveness concerns, (5) encouraging technology diffusion and spill-over, and lastly, (6) rewarding countries with the relatively least

emitting industries in each sector or ‘global best practise’ by making their exports more attractive for others to import while not punishing countries with ‘pollution intensive resource endowments’.

Because the frameworks mapped in Table 1 can lead to quite different reported emissions, it is relevant to assess the implications of their use for claims of GGG. As no framework is indisputably inherently superior, it seems fair to say that relying solely on one framework for assessing national developments is partial and can lead to potentially misleading claims. Here, we illustrate this by considering to what extent the choice of territorial, production-based and consumption-based accounting changes whether Denmark lives up to the GGG criteria (cf. eq. (1)). Interestingly, Stoknes and Rockström (2018) find that Finland, Sweden and Denmark have all ‘demonstrated genuine green growth in this century’ (p. 44). To illustrate this, they create an index for the carbon productivity of those countries, comparing it to a hypothesized GGG scenario based on 5% p.a. improvement in CAPRO. When indexing, they use average CAPRO in the years 2000–2003 is used as the baseline relative to the period 2004–2014. The corresponding graph illustrates increases in CAPRO for Denmark and Sweden that are very close to or even above the GGG line, which marks continual 5% improvements each year.

Wanting to engage with the approach applied by Stoknes and Rockström (2018), we first test if results are sensitive to the source of data using territorial carbon emission data from the Global Carbon Project (Global Carbon Project, 2019) (whereas Stoknes and Rockström rely on OECD Stats).<sup>9</sup> The Global Carbon Project database is suitable from an accounting perspective, because it treats bunker fuels as separate (Quéré et al., 2018) for both territorial (relying on Gilfillan et al. (2019) and national inventories as reported to UNFCCC (2019)) and consumption-based emissions (which are updated from (Peters et al., 2011a)).<sup>10</sup> Similar to Stoknes and Rockström (2018), we find a yearly increase in CAPRO around 5% for Denmark and Sweden when using territorial emissions (see Fig. 1), but a somewhat lower yearly increase for Finland.

Focusing on Denmark alone, we report a similar graph showing production-based emissions. We do so by adding CO<sub>2</sub> emissions from international transport that is regarded as Danish economic activity in national accounts (as reported by Statistics Denmark) to domestic carbon emissions.<sup>11</sup> This corresponds to attributing CO<sub>2</sub> emissions from the combustion of bunker fuels to the residence country of the operator<sup>12</sup>

<sup>9</sup> To ensure consistency with Stoknes and Rockström and to be able to refer to various carbon budgets, we here consider CO<sub>2</sub>-emissions only. However, the issues under consideration apply to GHGs other than CO<sub>2</sub> emissions as well as other environmental stressors.

<sup>10</sup> The consumption-based emissions reported Global Carbon Project (Global Carbon Project, 2019) relies on the Global Trade Analysis Project (GTAP) to create the MRIO used for environmentally extended multi regionalal input output (EEMRIO) analysis (Peters et al., 2011b, 2011a).

<sup>11</sup> The issue of integrating bunker fuels into an accounting framework is not clear cut. How should bunker fuels be shared between the exporting or importing party? With regard to international shipping, Heitmann and Khalilian contend that the UNFCCC has not put forward a ‘single allocation option that can be regarded as environmentally effective, legally effective and allowing for fair burden sharing’ (2011, p.682), although a recent study finds that attributing emissions to countries of ship owners is the approach which best meets criteria related to effectiveness and equity (Selin et al., 2021). Governance of international shipping is complicated by being multi-level, multi-purposed, multifunctional and heterogenic, arguably opening for a polycentric approach (Gritsenko, 2017). Yet, to address climate change, emissions from combustion bunker fuels need to be regulated and accounted for (ben Brahim et al., 2019; Heitmann and Khalilian, 2011; Kellner, 2016).

<sup>12</sup> As consistent with the economic approach to production-based emissions, the System of Environmental-Economic Accounting (United Nations et al., 2014) and EXIOBASE as well as option 4 put forward by the UNFCCC in its 1996 National Communication by the Subsidiary Body for Scientific and Technological Advice (SBSTA, 1996).



Fig. 1. Carbon productivity for Sweden, Denmark and Finland 2000–2017 (100 = 2000–2003 average) and 5%  $y^{-1}$  GGG requirement. Note: the 5% CAPRO line represents an increase of 5% p.a in carbon productivity from 2003 onwards, GDP statistics in 2010 USD from the World Bank.

(Heitmann and Khalilian, 2011; SBSTA, 1996). As monetary value added from activities using bunker fuels are included in GDP, emissions from the combustion of these should arguably be added to territorial emissions in studies of the relationship between a country's GDP and emissions (Pedersen and De Haan, 2008; Peters and Hertwich, 2008). Bunker fuels are especially important for the case of Denmark since the largest container shipping company in the world, Maersk, is headquartered in Copenhagen (maersk.com). The result in Fig. 2 illustrate that the observed CAPRO using production-based emissions is much lower than the 5% GGG threshold and that of the graph based on territorial emissions. In fact, Danish production-based emissions displayed hardly any absolute decoupling in the period covered with total yearly emissions being mostly constant. This means that the observed modest increase in Danish production-based CAPRO can be attributed to increases in GDP for most of the period.

Addressing the emission footprint of Nordic countries, we also compute changes in CAPRO over time using consumption-based carbon emissions from the Global Carbon Project (2019)<sup>13</sup> (see Fig. 3). As we are now considering CO<sub>2</sub> emissions embodied in consumption, we use real gross national expenditure (GNE) instead of GDP as the numerator when calculating CAPRO (the difference between GNE and GDP is modest for most countries). Still, taking 2000–2003 as the baseline, developments far from resemble GGG. While all of Sweden, Finland and Denmark show increasing CAPRO over the period, the increases are far below the 5%  $y^{-1}$  target.

### 3.2. Implications of the 1.5 °C target: Sensitivity to budget specification

Whilst claims of GGG examined above are tenuous relative to the 2 °C target, it could be increasingly argued that the more stringent 1.5 °C target should constitute the reference for sufficient decoupling. Justifications for this include the projected differences in risks between a 1.5 and 2 °C scenario (IPCC, 2018), the precautionary principle, current manifestations of tipping points (Lenton et al., 2019) and the language of the Paris Agreement (Anderson et al., 2020). In this section, we take the goal of limiting global warming to the 1.5 °C as starting point for operationalizing GGG and ask: what would be the required yearly increase in CAPRO to realise that? In order to relate to Section 3 and the provided definition of GGG (eq. (1)), we use an approach similar to

<sup>13</sup> Noticeably, emissions from LULUCF are not included here due to data inadequacies (Peters et al., 2011b, 2011a).

Stoknes and Rockström (2018). Assuming future global GDP (Gross World Product) growth of 3% pro anno, what is the required yearly increases in CAPRO to limit warming to 1.5 °C? The IPCC estimates of the remaining carbon budgets from 2018 with a 33%, 50% and 66% probability respectively of limiting warming to 1.5 °C range from 320 to 740 Gt CO<sub>2</sub> when including the effect of Earth System Feedbacks (Rogelj et al., 2018). With CO<sub>2</sub> emissions currently around 37 Gt per year, and relying on the more precautionary 66% probability budget including Earth System Feedbacks (320 Gt), this implies that the global emission must fall by around 11%  $y^{-1}$  in the period 2018–2050 (calculated using the 'goal seek' function in Excel). Hence, the global CAPRO target is 14%  $y^{-1}$  (3% + 11%) and, following the approximation of Stoknes and Rockström<sup>14</sup> this is the associated nation-level CAPRO target. Table 2 shows that less precautionary approaches to defining the carbon budget (i.e., 50% or 33% probability of achieving the 1.5 °C goal) lead to more modest CAPRO target. However, even the least precautionary approach (a carbon budget of 740 Gt CO<sub>2</sub>, corresponding to 33% probability of achieving the 1.5 °C goal) leads to a CAPRO target of 6%  $y^{-1}$ , which is historically unprecedented in the Nordic countries (despite considering domestic emissions only), as depicted in Fig. 4.

## 4. Discussion – What does it take to be genuine?

Oxford University Press defines genuine as 'truly what something is said to be' (Oxford University Press, 2020). In this sense, the term 'genuine' implies a promise. A promise of honesty, validity and sincerity. Dubbing something as genuine implies setting it clearly apart from that which could be considered doubtful, dubious and deceptive. GGG entails a positive qualitative difference from green growth as an oxymoron; GGG implies sufficient societal change. GGG is 'truly green' growth. GGG is *genuinely* green.

Therefore, one should not use the label 'genuine' lightly. Stoknes and Rockström (2018) tentatively suggested a general definition of GGG referring to varying environmental indicators relating to planetary

<sup>14</sup> Equating needed increases in CAPRO at the country level with needed efficiency improvements at the global level is an approximation, since countries have different growth rates and carbon intensities in the chosen basis year (Bjørn et al., 2021). Thus, this approach has clear limitations. However, to allow for comparison to the CAPRO for the 2 °C goal of Stoknes and Rockström (2018), we use the same approximation in estimating the CAPRO for the 1.5 °C goal.

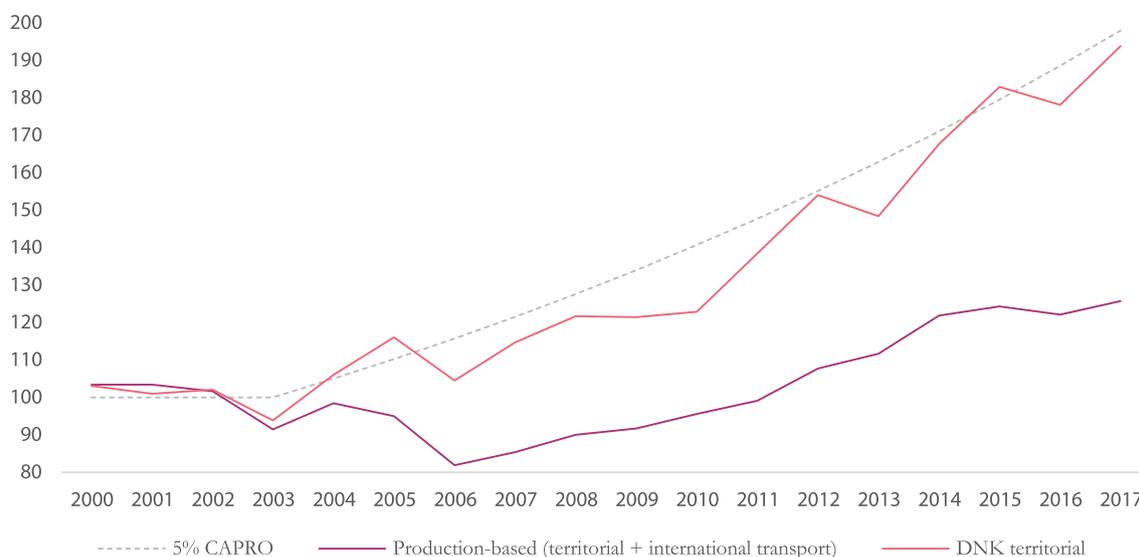


Fig. 2. Carbon productivity for Denmark 2000–2017 using production-based and territorial emissions and 5% y<sup>-1</sup> GGG requirement.

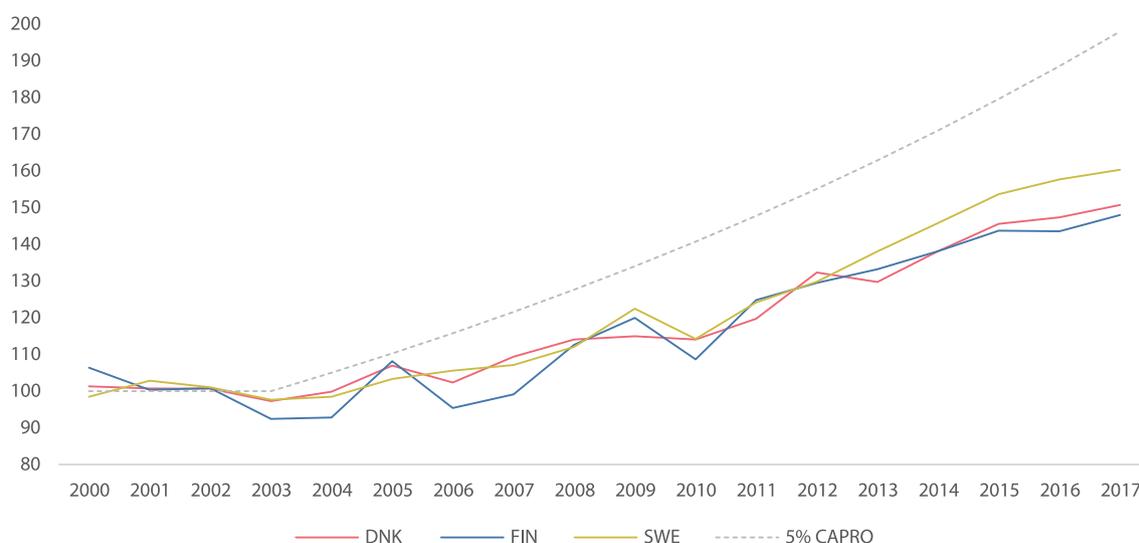


Fig. 3. Carbon productivity for Sweden, Denmark and Finland 2000–2017 (100 = 2000–2003 average) based on consumption-based emissions and GNE and 5% y<sup>-1</sup> GGG requirement.

**Table 2**  
CAPRO targets for the 1.5 °C goal according to different probabilities of achieving it.

Budget (Gt)	Needed yearly decrease in CO2 emissions 2018–2050	Implied needed yearly increase in CAPRO
320 (67th percentile of model simulations)	11%	14%
480 (50th percentile of model simulations)	7%	10%
740 (33rd percentile of model simulations)	3%	6%

Note: Authors' calculations based on IPCC (Rogelj et al., 2018) and the Global Carbon Project (Friedlingstein et al., 2019). Estimates of the remaining carbon budget include Earth System Feedbacks. Rounded to whole numbers.

boundaries collectively as resource productivity, RP:

$$\Delta RP > 5\% \tag{2}$$

Above we have illustrated the inadequacy of this criterion for the

case of carbon. We have based this on analyses of production-based and consumption-based emissions as well as the implications of focusing on the 1.5 °C target. We have thus exemplified some of the choices and challenges involved in moving from the abstract, such as the concept of GGG, into concrete and specific goals, such as the above, and the ambiguities that such a process inevitably invites. The example is far from exhaustive. Therefore, we continue here by discussing a range of other concerns of different orders of generality in relation to setting targets for (genuine) green growth.

One such concern is the universal character of the GGG criterion. Different countries have different starting points with widely ranging per capita absolute emissions. And while countries in the Global North typically are and have been net carbon importers (Wood et al., 2019) with higher consumption-based than territorial carbon emissions (Global Carbon Project, 2019), the reverse generally holds true for countries in the Global South. Failing to reflect differences between nations, a universal target neglects the principle of ‘common but differentiated responsibilities and respective capabilities’ as stated in the Paris Accords (Anderson et al., 2020) and related discussions of

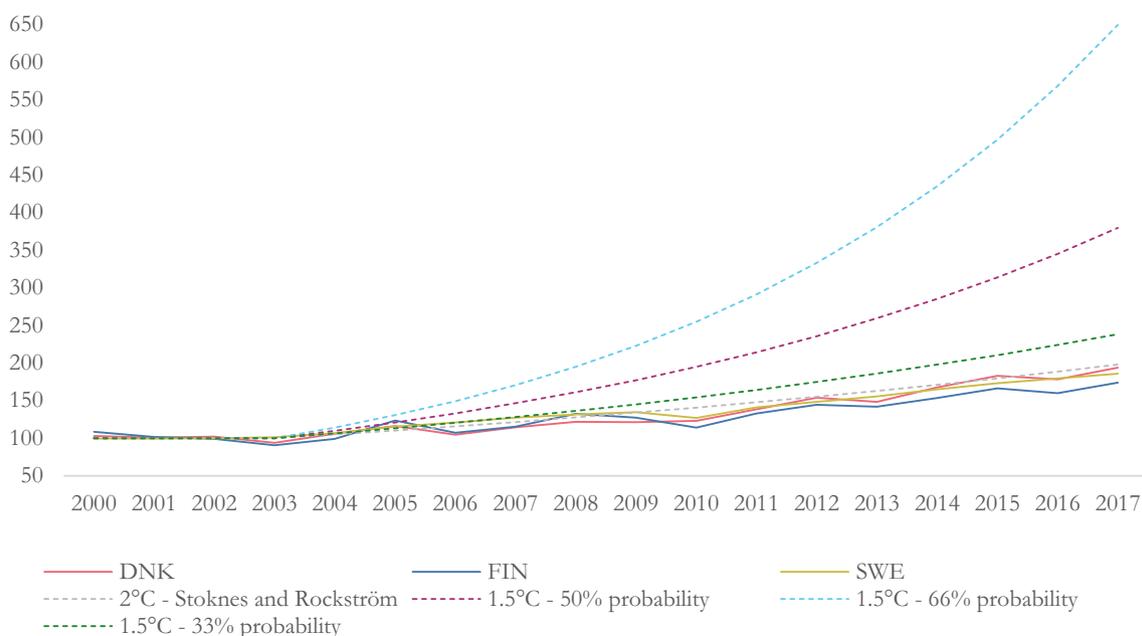


Fig. 4. Varying CAPRO-targets relying on different carbon budgets. Note: 100 = 2000–2003 average, country estimates identical to Fig. 1, CAPRO target lines based on Table 2, GDP data in 2010 USD.

historical responsibility, climatic conditions and ‘rights to develop’ (Starkey, 2008). Indeed, were the responsibility for historical emissions taken into account, Global North countries such as the ones under consideration here would be looking at (large) negative national level remaining carbon budgets (van den Berg et al., 2020). As such, addressing these principles completely changes the picture for what level of mitigation is needed for given temperature commitments (Anderson et al., 2020) and supports differentiating GGG targets to reflect national circumstances and responsibilities.

The concerns over universal criteria raised above also hint at a need for complementing quantitative assessments of GGG with considerations of a more qualitative character. For the case of Denmark, for example, any discussion of green growth would have to consider the role of biomass. A relatively large share of the Danish renewables’ portfolio is, and is likely to remain, bioenergy (Jørgensen and Andersen, 2012), with 67.5% of renewable energy consumption relying on biomass in 2018 (Danish Energy Agency, 2020a). In the UNFCCC framework, biomass is accounted for in the land use, land use change and forestry (LULUCF) sector in the emission inventories of the country in which the tree harvesting has occurred (as opposed to the country in which the biomass is put to use) (Berndes et al., 2020). Yet, this assumes that the scope of emissions from LULUCF is appropriately accounted for in national inventories and that countries include LULUCF-emissions in national reduction targets. This is, however, not necessarily the case. For example, one fourth of the biomass used for electricity generation in Denmark in 2018 was imported from Russia and the US, neither of which properly account for LULUCF (Danish Energy Agency, 2020b). To the extent that Danish consumption of biomass results in decreased forest carbon stocks in exporting countries, the resulting reductions in Danish national emissions are expressions of outsourcing of emissions rather than absolute reductions (Lund et al., 2019). Moreover, the potential for conflicts between climate and environmental concerns relating to bioenergy (e.g., in the case of biodiversity) (Hildingsson and Johansson, 2016) serves to illustrate the importance of not only multi-dimensional thinking but also how qualitative considerations are needed in relation to GGG assessment.

A related question is to what extent we can actually meaningfully capture planetary boundaries in single metrics. For example, global biodiversity experts struggle to define a unit to capture the complexity

and multi-faceted nature of the matter (Dempsey, 2016). Although comprehensive and consistent work is being pursued, the diversity of ecosystems means that choosing universal indicators for biodiversity and ecosystem conditions remains challenging (Hein et al., 2020). Thus, relating to (2), if we are to consider resource productivity a meaningful target, we first need to ask: What resource? Or, in the words of Costanza and Patten (1995), what system are we interested in sustaining? Such considerations become even more important given that we can only know whether a given system is sustainable *ex post* (Costanza and Patten, 1995). Because it is not possible to assess whether given targets result in the (sustainable) outcome we desire and hope for in real time, the definition of GGG is really a prediction. For example, we can only know whether certain emission pathways result in the predicted temperature after the emission have occurred. In their remaining carbon budgets, for example, the IPCC operates with both historical temperature uncertainty, uncertainty regarding the additional warming since 2006, uncertainty in recent emissions and, not least, the climate sensitivity<sup>15</sup> (Rogelj et al., 2018). Such considerations are relevant across ecological-economic systems, revealing that many definitions of sustainability are in essence predictors of system characteristics (Costanza and Patten, 1995). And as for predictions, uncertainty is a constitutive feature. This further underpins the need for elaboration, deliberation and disagreement that has already been called for in environmental governance (Dryzek and Pickering, 2017). Moreover, it constitutes an argument for setting the criteria for ‘genuine’ at a level that ensures that the temperature goal is met even if the majority of the uncertainties fall out in favour of more warming (if one is risk averse, at least). Relying on the upper end of the 2 °C Gt carbon budget interval as in (1) conflicts with this principle.

Considering GGG as a policy goal, it is worth reflecting on the ways in which the distinction implied by the definition of GGG is problematic for governing something as diverse and complex as environmental quality. By classifying a certain development as ‘genuinely green’, a dichotomy is produced, grouping heterogeneous cases of expansions of

<sup>15</sup> Another part of the explanation for substantial uncertainty relates to the issue of carbon accounting in that the ‘remaining carbon budget’ depends on emissions of other GHGs (Rogelj et al., 2018).

production as binary examples of either or (one of which is subordinate). Multifaceted and complex cases of economy and ecology, their interactions and contradictions, are reduced to a categorical variable despite trade-offs between different environmental objectives (Hoekstra and Wiedmann, 2014). Drawing on Dryzek and Pickering's (2017) reflections on the composition of public discourse as a dimension of governance (along which reflexivity might be sought) and its tension (diversity vs. consensus), we can understand the GGG definition as an effort of 'closing down' (Stirling, 2008; Voss et al., 2006), i.e. establishing a level of discursive agreement to determine a specific course of action, leaving aside or bracketing unresolved uncertainty (Voss et al., 2006, p. 431; Walker et al., 2006, p. 8). Although potentially enabling action by setting a goal through operationalizing GGG, closing down and establishing consensus is prone to criticisms arising from lack of diversity. Dryzek and Pickering (2017) cite Habermas (1996) when pointing to the notion that diversity is important for both critical scrutiny of current governance practices, ideas and discourses as well as for generating new ones. Seeing the prominence of the ecological modernization discourse, diversity, pluralism and scepticism is needed to not readily accept mainstream views that have historically marginalized environmental concerns (Söderbaum, 2013). In this sense, notwithstanding the criticisms of GGG raised in previous sections, it might be counterproductive to define or set a fixed target for GGG in an effort to 'close down' without allowing for 'reopening' and continued reflexivity.

A similar criticism can be raised against absolute targets derived from ecological limits, as such processes also involve 'closing down'. Illustrated by the importance of carbon accounting, the 1.5 °C goal and the 'common but differentiated responsibilities' principle, any absolute emission target reflect certain positions which can (and should) be contested. For example, the target of reducing territorial emissions by 70% compared to 1990 guiding Danish climate policy (The Danish Ministry of Climate Energy and Utilities, 2019) is prone to all of the criticisms raised in this paper. However, absolute targets do not come with the same implicit assumptions that growth in GDP is necessary and good.

This returns us to the debate on the contested role of growth in post-COVID trajectories. Although GGG and degrowth share the goal of putting the global economy on a path that respects planetary boundaries,<sup>16</sup> the approaches differ in how this path is envisioned. Proponents of degrowth broadly conceive of this path as one where the social metabolism or 'throughput' of the economy decreases and where economic growth is abandoned as a measure of human progress, explicitly addressing social equity and environmental justice, whereas GGG emphasizes a path of increased efficiency of resource use, while implicitly lending continued support to economic growth as a worthy policy objective. In this sense, GGG is an effort to rescue green growth and support a (genuine) 'win-win frame' over a 'cut- and loss frame' (Stoknes and Rockström, 2018, p. 42) in the hope of forwarding a more politically appealing narrative. Our analysis of the prospects of GGG indicates that this attempt at rescuing a recognizable 'win-win frame' suffers from partiality and can potentially be misleading.

## 5. Conclusion

This article starts from the perspective that present debates about climate policy in the context of COVID-19 amidst an accelerating climate crisis are characterized by a discrepancy between rhetoric, intention and policy action. Or put more bluntly; that climate governance is characterized by 'bullshit' (Stevenson, 2020). Seeing that historical decoupling rates have been insufficient to achieve global climate policy goals

<sup>16</sup> Which formulation of GGG one is referring to is pivotal in this regard. As illustrated, formulations of GGG can differ substantially regarding both the ambition of goals, the type of indicators used to measure them and the way in which these are accounted for.

(Haberl et al., 2020; Hickel and Kallis, 2020), we asked the question of how that can be reconciled with the narrative of Nordic countries as frontrunners and examples of genuine green growth. The answer is that the claim of genuine green growth in the Nordics relies on a number of disputed choices namely (1) focusing on climate change only, (2) considering territorial emissions only, (3) relying on a high estimate end of the 2 °C remaining carbon budget (4) disregarding the principle of 'common but differentiated responsibilities and respective capabilities' and (5) ignoring country specific contingencies (as the role of biomass for the case of Denmark). In the light of this, the Nordic countries cannot be said to have demonstrated genuine green growth in this century. Nor do Nordic countries provide templates for decarbonization that can be emulated by other countries in the sense that the reproduction of Nordic societies and lifestyles is set to continue to demand a disproportionate share of the remaining global carbon budget (Lund et al., 2019). A question that therefore remains is: what is the alternative to GGG as a policy goal? Arguably, aggregate incremental measures of change (such as GGG) fail to capture the needed transformative change required to current sociotechnical systems, pointing to the important divide of incremental vis-a-vis transformative change (Rosenbloom et al., 2020) and approaches towards opening up such as multicriteria mapping (Stirling, 2008, 2010).

Such considerations raise the question of how emissions contribute to and counteract human well-being. Indeed, the notion of GGG with its focus on growth and territorial emissions fails to address that. Instead, an orientation towards a foundation of human needs appears more relevant (Gough, 2015; Koch et al., 2017; Millward-Hopkins et al., 2020). In this regard, we must improve our understanding of how and in which ways well-being, starting from human needs and as expressed by social indicators, currently relies on GHG emissions (and other environmental stressors), seeking ways to increase the former whilst reducing the latter (Steinberger et al., 2020). Hereby, we add to the call made by other scholars (Haberl et al., 2020) for further research on the interdependencies between well-being, resources and emissions, answering questions of how to square well-being and satisfaction of human needs with genuinely sustainable levels of consumption in the Nordics and elsewhere.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References

- Aichele, R., Felbermayr, G., 2012. Kyoto and the carbon footprint of nations. *J. Environ. Econ. Manag.* 63, 336–354. <https://doi.org/10.1016/j.jeem.2011.10.005>.
- Anderson, K., Broderick, J.F., Stoddard, I., 2020. A factor of two: how the mitigation plans of 'climate progressive' nations fall far short of Paris-compliant pathways. *Clim. Pol.* 1–15. <https://doi.org/10.1080/14693062.2020.1728209>.
- Barlow, N., Chertkovskaya, E., Grebenjak, M., Liegey, V., Schneider, F., Smith, T., Bliss, S., Hepp, C., Hollweg, M., Kerschner, C., Rilović, A., Khanna, P.S., Saey-Volkcrick, J., 2020. Press release: 1,100 Experts Call for Degrowth as Post-COVID-19 Path [WWW document]. URL: <https://www.degrowth.info/en/press-release/>.
- ben Brahim, T., Wiese, F., Münster, M., 2019. Pathways to climate-neutral shipping: A Danish case study. *Energy* 188, 116009. <https://doi.org/10.1016/j.energy.2019.116009>.
- Berndes, G., Cowie, A.L., Pelkmans, L., 2020. The Use of Forest Biomass for Climate Change Mitigation: Dispelling some Misconceptions [WWW Document]. URL: <https://www.ieabioenergy.com/wp-content/uploads/2020/08/The-use-of-biomass-for-climate-change-mitigation-dispelling-some-misconceptions-August-2020-Rev1.pdf>.
- Bjørn, A., Lloyd, S., Matthews, D., 2021. From the Paris agreement to corporate climate commitments: evaluation of seven methods for setting "science-based" emission targets. *Environ. Res. Lett.* <https://doi.org/10.1088/1748-9326/abe57b>.
- Brand, U., 2012. Green economy - the next oxymoron? *GAIA. Ecol. Perspect. Sci. Soc.* 21, 5.
- Christoff, P., 1996. Ecological modernisation, ecological modernities. *Env. Polit.* 5, 476–500.
- Costanza, R., Patten, B.C., 1995. Defining and predicting sustainability. *Ecol. Econ.* 15, 193–196.

- Danish Energy Agency, 2020a. Energy Statistics 2018 [WWW Document]. URL [https://ens.dk/sites/ens.dk/files/Statistik/energy\\_statistics\\_2018.pdf](https://ens.dk/sites/ens.dk/files/Statistik/energy_statistics_2018.pdf).
- Danish Energy Agency, 2020b. Biomasseanalyse [WWW Document]. URL [https://ens.dk/sites/ens.dk/files/Bioenergi/biomasseanalyse\\_final\\_ren.pdf](https://ens.dk/sites/ens.dk/files/Bioenergi/biomasseanalyse_final_ren.pdf).
- Dempsey, J., 2016. *Enterprising Nature: Economics, Markets, and Finance in Global Biodiversity Politics*. John Wiley & Sons.
- Dorninger, C., Hornborg, A., Abson, D.J., Von Wehrden, H., Schaffartzik, A., Giljum, S., Engler, J., Feller, R.L., Hubacek, K., 2021. Global patterns of ecologically unequal exchange: implications for sustainability in the 21st century. *Ecol. Econ.* 179, 106824. <https://doi.org/10.1016/j.ecolecon.2020.106824>.
- Dryzek, J.S., 2017. *The Politics of the Earth*, 3rd ed. Oxford University Press, Oxford. <https://doi.org/10.1093/hepl/9780199696000.001.0001>.
- Dryzek, J.S., Pickering, J., 2017. Degrowth as a catalyst for reflexive environmental governance. *Ecol. Econ.* 131, 353–360. <https://doi.org/10.1016/j.ecolecon.2016.09.011>.
- Fix, B., Nitzan, J., Bichler, S., 2019. Real GDP: the flawed metric at the heart of macroeconomics. *Real-world Econ. Rev.* 51–59.
- Friedlingstein, P., Jones, M.W., O'Sullivan, M., Andrew, R.M., Hauck, J., Peters, G.P., Peters, W., Pongratz, J., Sitch, S., Le Quére, C., DBakker, O.C.E., Canadell, J.G., Ciais, P., Jackson, R.B., Anthoni, P., Barbero, L., Bastos, A., Bastrikov, V., Becker, M., Bopp, L., Buitenhuis, E., Chandra, N., Chevallier, F., Chini, L.P., Currie, K.I., Feely, R. A., Gehlen, M., Gilfillan, D., Gkritzalis, T., Goll, D.S., Gruber, N., Gutekunst, S., Harris, I., Haverd, V., Houghton, R.A., Hurtt, G., Ilyina, T., Jain, A.K., Joetzjer, E., Kaplan, J.O., Kato, E., Goldewijk, K.K., Korsbakken, J.I., Landschützer, P., Lauwet, S. K., Lefèvre, N., Lenton, A., Lienert, S., Lombardozi, D., Marland, G., McGuire, P.C., Melton, J.R., Metz, N., Munro, D.R., Nabel, J.E.M.S., Nakaoka, S.I., Neill, C., Omar, A.M., Ono, T., Peregón, A., Pierrot, D., Poulter, B., Rehder, G., Resplandy, L., Robertson, E., Rödenbeck, C., Séférian, R., Schwingler, J., Smith, N., Tans, P.P., Tian, H., Tilbrook, B., Tubiello, F.N., Van Der Werf, G.R., Wiltshire, A.J., Zaehle, S., 2019. Global carbon budget 2019. *Earth Syst. Sci. Data* 11, 1783–1838. <https://doi.org/10.5194/essd-11-1783-2019>.
- Gilfillan, D., Marland, G., Boden, T., Andres, R., 2019. Global, Regional, and National Fossil-Fuel CO<sub>2</sub> Emissions [WWW document]. URL <https://energy.appstate.edu/CDIAC>.
- Global Carbon Project, 2019. Supplemental Data of Global Carbon Budget 2019 (Version 1.0) [Data set]. Global Carbon Project. <https://doi.org/10.18160/gcp-2019>.
- Gough, I., 2015. Climate change and sustainable welfare: the centrality of human needs. *Camb. J. Econ.* 39, 1191–1214. <https://doi.org/10.1093/cje/bev039>.
- Gritsenko, D., 2017. Regulating GHG emissions from shipping: local, global, or polycentric approach? *Mar. Policy* 84, 130–133. <https://doi.org/10.1016/j.marpol.2017.07.010>.
- Haberl, H., Wiedenhofer, D., Virág, D., Kalt, G., Plank, B., Brockway, P., Fishman, T., Hausknost, D., Krausmann, F.P., Leon-Gruchalski, B., Mayer, A., Pichler, M., Schaffartzik, A., Sousa, T., Streeck, J., Creutzig, F., Pichler, M., Mayer, A., Krausmann, F.P., Brockway, P., Schaffartzik, A., Fishman, T., Hausknost, D., Leon-Gruchalski, B., Sousa, T., Creutzig, F., 2020. A systematic review of the evidence on decoupling of GDP, resource use and GHG emissions, part II: synthesizing the insights. *Environ. Res. Lett.* <https://doi.org/10.1088/1748-9326/ab842a>.
- Habermas, J., 1996. *Between Facts and Norms*. The MIT Press. <https://doi.org/10.7551/mitpress/1564.001.0001>.
- Hajer, M.A., 1995. *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process*. Clarendon, Oxford. <https://doi.org/10.1093/019829333X.001.0001>.
- Hein, L., Bagstad, K.J., Obst, C., Edens, B., Schenau, S., Castillo, G., Souldard, F., Brown, C., Driver, A., Bordt, M., Steurer, A., Harris, R., Caparrós, A., 2020. Progress in natural capital accounting for ecosystems. *Science* (80- ). 367, 514–515. <https://doi.org/10.1126/science.aaz8901>.
- Heitmann, N., Khalilian, S., 2011. Accounting for carbon dioxide emissions from international shipping: burden sharing under different UNFCCC allocation options and regime scenarios. *Mar. Policy* 35, 682–691. <https://doi.org/10.1016/j.marpol.2011.02.009>.
- Hepburn, C., O'Callaghan, B., Stern, N., Stiglitz, J., Zenghelis, D., 2020. Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change? *Oxf. Rev. Econ. Policy* 36, S359–S381. <https://doi.org/10.1093/oxrep/gra015>.
- Hickel, J., 2019. Degrowth: a theory of radical abundance. *Real-world Econ. Rev.* 87, 54–68.
- Hickel, J., Kallis, G., 2020. Is green growth possible? *New Polit. Econ.* 25, 469–486. <https://doi.org/10.1080/13563467.2019.1598964>.
- Hildingsson, R., Johansson, B., 2016. Governing low-carbon energy transitions in sustainable ways: potential synergies and conflicts between climate and environmental policy objectives. *Energy Policy* 88, 245–252. <https://doi.org/10.1016/j.enpol.2015.10.029>.
- Hoekstra, A.Y., Wiedmann, T.O., 2014. Humanity's unsustainable environmental footprint. *Science* (80- ). <https://doi.org/10.1126/science.1248365>.
- IPBES, 2019. *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. In: Brondizio, E.S., Settele, J., Díaz, S., Ngo, H.T. (Eds.), IPBES Secretariat. Bonn, Germany.
- IPCC, 2018. *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 [Masson-Delmotte, V., 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, and T. Waterfield]. In Press.
- Jørgensen, M.S., Andersen, B.H., 2012. The controversies over bioenergy in denmark: “Bio” is not the same as “sustainable.” *Environ. Eng. Manag. J.* 11, 2101–2119. <https://doi.org/10.30638/eej.2012.262>.
- Kallis, G., 2018. The utopia of degrowth. In: *Degrowth*. Agenda Publishing, pp. 117–148. <https://doi.org/10.2307/j.ctv5c8g2g.8>.
- Kallis, G., Kostakis, V., Lange, S., Muraca, B., Paulson, S., Schmelzer, M., 2018. Research on degrowth. *Annu. Rev. Environ. Resour.* <https://doi.org/10.1146/annurev-environ-102017-025941>.
- Kellner, F., 2016. Allocating greenhouse gas emissions to shipments in road freight transportation: suggestions for a global carbon accounting standard. *Energy Policy* 98, 565–575. <https://doi.org/10.1016/j.enpol.2016.09.030>.
- Koch, M., Buch-Hansen, H., Fritz, M., 2017. Shifting priorities in degrowth research: an argument for the centrality of human needs. *Ecol. Econ.* 138, 74–81. <https://doi.org/10.1016/j.ecolecon.2017.03.035>.
- Kvangraven, I.H., 2020. Beyond the stereotype: restating the relevance of the dependency research programme. *Dev. Change* Dech. 12593 <https://doi.org/10.1111/dech.12593>.
- Lenton, T.M., Rockström, J., Gaffney, O., Rahmstorf, S., Richardson, K., Steffen, W., Schellnhuber, H.J., 2019. Climate tipping points - too risky to bet against. *Nature* 575, 592–595.
- Liu, L., 2015. A critical examination of the consumption-based accounting approach: has the blaming of consumers gone too far? *Wiley Interdiscip. Rev. Clim. Chang.* 6, 1–8. <https://doi.org/10.1002/wcc.325>.
- Lohmann, L., 2009. Toward a different debate in environmental accounting: the cases of carbon and cost-benefit. *Acc. Organ. Soc.* 34, 499–534. <https://doi.org/10.1016/j.aos.2008.03.002>.
- Lövbrand, E., Stripple, J., 2011. Making climate change governable: accounting for carbon as sinks, credits and personal budgets. *Crit. Policy Stud.* 5, 187–200. <https://doi.org/10.1080/19460171.2011.576531>.
- Lund, J.F., Bjørn, A., Simonsen, M.B., Jacobsen, S.G., Blok, A., Jensen, C.L., 2019. Outsourcing og omstilling: de danske drivhusgasudledninger genfortolket. *Samfundsøkonomen* 15–24.
- Mazzucato, M., 2018. *The Value of Everything: Making and Taking in the Global Economy*. Allen Lane, Lond.
- Mazzucato, M., Shipman, A., 2014. Accounting for productive investment and value creation. *Ind. Corp. Chang.* 23, 1059–1085.
- Millward-Hopkins, J., Steinberger, J.K., Rao, N.D., Oswald, Y., 2020. Providing decent living with minimum energy: a global scenario. *Glob. Environ. Chang.* 65, 102168. <https://doi.org/10.1016/j.gloenvcha.2020.102168>.
- Mol, A.P.J., Spaargaren, G., 2000. Ecological modernisation theory in debate: a review. *Env. Polit.* 9, 17–49.
- Obama, B., 2017. The irreversible momentum of clean energy. *Science* (80- ). 355, 126–129.
- Oxford University Press, 2020. Definition of Genuine [WWW Document]. Lexico. URL <https://www.lexico.com/definition/genuine> (accessed 11.9.20).
- Parguel, B., Benoît-Moreau, F., Larceneux, F., 2011. How sustainability ratings might deter “Greenwashing”: a closer look at ethical corporate communication. *J. Bus. Ethics* 102, 15–28. <https://doi.org/10.1007/s10551-011-0901-2>.
- Pedersen, O.G., De Haan, M., 2008. The system of environmental and economic accounts-2003 and the economic relevance of physical flow accounting. *J. Ind. Ecol.* 10, 19–42. <https://doi.org/10.1162/10881980677554566>.
- Peters, G.P., Hertwich, E.G., 2008. Post-Kyoto greenhouse gas inventories: production versus consumption. *Clim. Chang.* 86, 51–66. <https://doi.org/10.1007/s10584-007-9280-1>.
- Peters, G.P., Andrew, R., Lennox, J., 2011a. Constructing an environmentally extended multi-regional input-output table using the gap database. *Econ. Syst. Res.* 23, 131–152. <https://doi.org/10.1080/09535314.2011.563234>.
- Peters, G.P., Minx, J.C., Weber, C.L., Edenhofer, O., 2011b. Growth in emission transfers via international trade from 1990 to 2008. *Proc. Natl. Acad. Sci. U. S. A.* 108, 8903–8908. <https://doi.org/10.1073/pnas.1006388108>.
- Petridis, P., Muraca, B., Kallis, G., 2015. Degrowth: between a scientific concept and a slogan for a social movement. In: *Martinez-Alier, J., Muradian, R. (Eds.), Handbook of Ecological Economics*. Edward Elgar Publishing.
- Pirgmaier, E., Steinberger, J.K., 2019. Roots, riots, and radical change—a road less travelled for ecological economics. *Sustainability* 11, 2001. <https://doi.org/10.3390/su11072001>.
- Quére, C., Andrew, R., Friedlingstein, P., Sitch, S., Hauck, J., Pongratz, J., Pickers, P., Ivar Korsbakken, J., Peters, G., Canadell, J., Armeth, A., Arora, V., Barbero, L., Bastos, A., Bopp, L., Ciais, P., Chini, L., Ciais, P., Doney, S., Gkritzalis, T., Goll, D., Harris, I., Haverd, V., Hoffman, F., Hoppema, M., Houghton, R., Hurtt, G., Ilyina, T., Jain, A., Johannessen, T., Jones, C., Kato, E., Keeling, R., Klein Goldewijk, K., Landschützer, P., Lefèvre, N., Lienert, S., Liu, Z., Lombardozi, D., Metz, N., Munro, D., Nabel, J., Nakaoka, S.I., Neill, C., Olsen, A., Ono, T., Patra, P., Peregón, A., Peters, W., Peylin, P., Pfeil, B., Pierrot, D., Poulter, B., Rehder, G., Resplandy, L., Robertson, E., Rocher, M., Rödenbeck, C., Schuster, U., Skjelvan, I., Séférian, R., Skjelvan, I., Steinhoff, T., Sutton, A., Tans, P., Tian, H., Tilbrook, B., Tubiello, F., Van Der Laan-Luijckx, I., Van Der Werf, G., Viovy, N., Walker, A., Wiltshire, A., Wright, R., Zaehle, S., Zheng, B., 2018. Global carbon budget 2018. *Earth Syst. Sci. Data* 10, 2141–2194. <https://doi.org/10.5194/essd-10-2141-2018>.
- Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F.S., Lambin, E., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., Foley, J., 2009. Planetary boundaries: exploring the safe operating space for humanity. *Ecol. Soc.* 14 <https://doi.org/10.5751/ES-03180-140232>.

- Rogelj, J., Schaeffer, M., Friedlingstein, P., Gillett, N.P., Van Vuuren, D.P., Riahi, K., Allen, M., Knutti, R., 2016. Differences between carbon budget estimates unravelled. *Nat. Clim. Chang.* <https://doi.org/10.1038/nclimate2868>.
- Rogelj, J., Shindell, D., Jiang, K., Fifita, S., Forster, P., Ginzburg, V., Handa, C., Khesghi, H., Kobayashi, S., Kriegler, E., Mundaca, L., Séférian, R., Vilarinho, M.V., 2018. Mitigation pathways compatible with 1.5°C in the context of sustainable development, in: Masson-Delmotte, V., Zhai, P., Pörtner, H.-O., Roberts, D., Skea, J., Shukla, P.R., Pirani, A., Moufouma-Okia, W., Péan, C., Pidcock, R., Connors, S., Matthews, J.B.R., Chen, Y., Zhou, X., Gomis, M.I., Lonnoy, E., Maycock, T., Tignor, M., Waterfield, T. (Eds.), *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* [Masson-Delmotte, V., 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, and T. Waterfield]. In Press.
- Røpke, I., 2005. Trends in the development of ecological economics from the late 1980s to the early 2000s. *Ecol. Econ.* 55, 262–290. <https://doi.org/10.1016/j.ecolecon.2004.10.010>.
- Rosenbloom, D., Markard, J., Geels, F.W., Fuenfschilling, L., 2020. Why carbon pricing is not sufficient to mitigate climate change—and how “sustainability transition policy” can help. *Proc. Natl. Acad. Sci. U. S. A.* 117, 8664–8668. <https://doi.org/10.1073/pnas.2004093117>.
- SBSTA, 1996. 1996 National Communication by the Subsidiary Body for Scientific and Technological Advice. FCCC/SBSTA/1996/9/Add.1.
- Schmelzer, M., 2016. *The Hegemony of Growth*. Cambridge University Press, Cambridge. <https://doi.org/10.1017/CBO9781316452035>.
- Selin, H., Zhang, Y., Dunn, R., Selin, N.E., Lau, A.K.H., 2021. Mitigation of CO2 emissions from international shipping through national allocation. *Environ. Res. Lett.* <https://doi.org/10.1088/1748-9326/abec02>.
- Söderbaum, P., 2013. Ecological economics in relation to democracy, ideology and politics. *Ecol. Econ.* 95, 221–225. <https://doi.org/10.1016/j.ecolecon.2013.05.017>.
- Starkey, R., 2008. *Allocating Emissions Rights: Are equal Shares, Fair Shares?* (no. 118). Tyndall Working Paper.
- State of Green, 2020. *Green Growth Is the Sustainable Way out of the Corona Crisis* [WWW Document]. URL: <https://stateofgreen.com/en/partners/state-of-green/news/green-growth-is-the-sustainable-way-out-of-the-corona-crisis/>.
- Steinberger, J.K., Lamb, W.F., Sakai, M., 2020. Your money or your life? The carbon-development paradox. *Environ. Res. Lett.* 15, 044016. <https://doi.org/10.1088/1748-9326/ab7461>.
- Stevenson, H., 2020. Reforming global climate governance in an age of bullshit. *Globalizations* 0, 1–17. <https://doi.org/10.1080/14747731.2020.1774315>.
- Stirling, A., 2008. “Opening up” and “closing down”: power, participation, and pluralism in the social appraisal of technology. *Sci. Technol. Hum. Values* 33, 262–294. <https://doi.org/10.1177/0162243907311265>.
- Stirling, A., <https://doi.org/10.1038/4681029a>.
- Stoknes, P.E., Rockström, J., 2018. Redefining green growth within planetary boundaries. *Energy Res. Soc. Sci.* 44, 41–49. <https://doi.org/10.1016/j.erss.2018.04.030>.
- Taherzadeh, O., 2021. Promise of a green economic recovery post-Covid: Trojan horse or turning point? *Glob. Sustain.* <https://doi.org/10.1017/sus.2020.33>.
- The Danish Ministry of Climate Energy and Utilities, 2019. *Denmark's Integrated National Energy and Climate Plan under THE REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the Governance of the Energy Union and Climate Action* [WWW Document]. URL: [https://ec.europa.eu/energy/sites/ener/files/documents/dk\\_final\\_necp\\_main\\_en.pdf](https://ec.europa.eu/energy/sites/ener/files/documents/dk_final_necp_main_en.pdf).
- UNFCCC, 2015. *Decision 1/CP.21, Paris agreement, document FCCC/CP/2015/10/Add.1. United Nations, Paris.*
- UNFCCC, 2019. *National Inventory Submissions 2019* [WWW Document]. URL. In: <https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/national-inventory-submissions-2019> (accessed 11.14.20).
- United Nations, European Commission, Food and Agriculture Organization, Organisation for Economic Co-operation and Development, World Bank, 2014. *System of Environmental-Economic Accounting 2012 - Central Framework*.
- van den Berg, N.J., van Soest, H.L., Hof, A.F., den Elzen, M.G.J., van Vuuren, D.P., Chen, W., Drouet, L., Emmerling, J., Fujimori, S., Höhne, N., Köberle, A.C., McCollum, D., Schaeffer, R., Shekhar, S., Vishwanathan, S.S., Vrontisi, Z., Blok, K., 2020. Implications of various effort-sharing approaches for national carbon budgets and emission pathways. *Clim. Chang.* 162, 1805–1822. <https://doi.org/10.1007/s10584-019-02368-y>.
- Voss, J.-P., Bauknecht, D., Kemp, R., 2006. *Reflexive Governance for Sustainable Development*. Edward Elgar Publishing.
- Walker, B., Gunderson, L., Kinzig, A., Folke, C., Carpenter, S., Schultz, L., 2006. A handful of heuristics and some propositions for understanding resilience in social-ecological systems. *Ecol. Soc.* 11 <https://doi.org/10.5751/ES-01530-110113>.
- Watanabe, C., Naveed, K., Tou, Y., Neittaanmäki, P., 2018. Measuring GDP in the digital economy: increasing dependence on uncaptured GDP. *Technol. Forecast. Soc. Change* 137, 226–240. <https://doi.org/10.1016/j.techfore.2018.07.053>.
- Weiss, M., Cattaneo, C., 2017. Degrowth – taking stock and reviewing an emerging academic paradigm. *Ecol. Econ.* <https://doi.org/10.1016/j.ecolecon.2017.01.014>.
- Wiedenhofer, D., Virág, D., Kalt, G., Plank, B., Streeck, J., Pichler, M., Mayer, A., Krausmann, F.P., Brockway, P., Schaffartzik, A., Fishman, T., Hausknost, D., Leon-Gruchaliski, B., Sousa, T., Creutzig, F., Haberl, H., 2020. A systematic review of the evidence on decoupling of GDP, resource use and GHG emissions, part I: bibliometric and conceptual mapping. *Environ. Res. Lett.* <https://doi.org/10.1088/1748-9326/ab8429>.
- Wood, R., Grubb, M., Anger-Kraavi, A., Pollitt, H., Rizzo, B., Alexandri, E., Stadler, K., Moran, D., Hertwich, E., Tukker, A., 2019. Beyond peak emission transfers: historical impacts of globalization and future impacts of climate policies on international emission transfers. *Clim. Pol.* 0, 1–14. <https://doi.org/10.1080/14693062.2019.1619507>.