# Is genuine green growth possible?

## Introduction

Since the industrial revolution in the 19th century, global economic output has increased more than 10-fold as a result of vast improvements in industrial productivity **spurred to a large extent by the availability of cheap fossil fuel energy** (Roser, 2019; Fouquet, 2019). This expansion of economic activity has resulted in improved living standards for people all over the planet, and the number of people living in absolute poverty has been reduced drastically (Dale, 2012; Rosling et al., 2018). It was not until the middle of the 20th century, however, that economic growth, as measured by increases in Gross Domestic Product (GDP), became a central policy objective on international as well as domestic level **in its own right** (Fioramonti, 2013; Jackson, 2019). Since then, the focus on economic growth has increased massively, and economic expansion has become equated with development, perceived as necessary for human wellbeing **under** the existing hegemonic ‘growth paradigm’ (Dale, 2012; Buchs and Koch, 2017; Philipsen, 2015). The stability of the global economic system currently depends on continuous economic growth given that production is motivated by profit under capitalism, and periods of slow growth, no growth, or negative growth, therefore lead to a **state of crisis** (Kallis et al., 2015; Andreucci and McDonough, 2015; Magdoff and Bellamy Foster, 2011; Hoffman, 2016; Victor, 2015). As a consequence of the profit motive, employment is closely tied to economic growth, and periods of slow growth lead to vast increases in unemployment and, consequently, decreased wellbeing (Magdoff and Bellamy Foster, 2011; Kallis et al., 2012). As argued by Kallis et al. (2015: 10), economic growth can therefore be understood to be imperative for capitalism in the sense that it “avoids redistributive conflict and sustains capitalism politically”.

The hegemony of the growth paradigm can perhaps most clearly be observed in the mainstream responses to the growing awareness of the effect of industrial economic activity on the natural environment. Since the 1970s, it has been increasingly recognised that economic expansion has not only resulted in improved living standards, but also put increased pressure on the natural environment as ever more natural resources are consumed, natural habitats and ecosystems destroyed, and the combustion of fossil fuels **results** in the emission of greenhouse gases (GHGs) into the atmosphere (Death, 2013). Mounting evidence shows that if human economic activity continues on its current path, we will transgress various ‘planetary boundaries’, and destabilise the currently stable state of the Earth System (ES) - the Holocene (Rockström et al., 2009; Steffen et al., 2015). The Holocene refers to the current geological epoch which dates back approximately 12,000 years, and it was during this epoch that humans began to create societies, as the relatively stable climate made farming possible (Magdoff and Bellamy Foster, 2011). Human civilisation is therefore dependent on the stability of the ES, and it is imperative to reduce the pressure of human economic activity on the environment and avoid substantially transgressing the planetary boundaries.

Of the nine planetary boundaries that have been identified, biosphere integrity (biodiversity loss) and climate change are the only **ones** that alone could result in destabilisation of the ES if transgressed (Steffen et al., 2015). We are currently on a path to **approximately 4C** increases in average temperatures under business as usual (BAU), and such global warming could push the earth system into a new **state** as various ‘tipping points’ are reached after which processes of self-reinforcing feedback cause ‘run-away’ warming (Hickel and Kallis, 2019; Cool Earth, 2018; …). Recent research shows that some tipping points may be reached at temperature increases of only 2C (Steffen et al., 2018). It is therefore imperative to stabilise the concentration of GHGs in the atmosphere as soon as possible to limit the increases in global temperatures, and in December 2015 the Paris Agreement was adopted by 195 countries, with the goal of limiting anthropogenic global warming to well below 2C by 2100, aiming for 1.5C (Falkner, 2016). In October 2018 the International Panel on Climate Change (IPCC) released a report that states that we need to reduce CO2 emissions 45% (25%) compared to 2010 levels by 2030 and reach net-zero by 2050 (2075) if we are to have >66% chance of limiting global warming to 1.5C (2C) (Rogelj et al., 2018). This would entail global reductions of GHG emissions by about 6.8% (4%) each year (Hickel and Kallis, 2019).

Given the centrality of economic growth on the international policy agenda, discussions about the relationship between economic activity and the environment have been, and still are, dominated by theories about ecological modernisation that reject the idea that economic growth necessarily will result in environmental degradation, arguing instead that it is possible to ‘decouple’ economic growth from increasing environmental pressures (Turner and Katris, 2019). As the severity of various environmental issues has become increasingly recognised during the past two decades, the idea of decoupling has **received** an **upsurge**, under the term of ‘green growth’ (Fiorino, 2018). Support for the idea of green growth has grown massively over the past decade, and green growth is today being promoted as *the* solution to climate change and other environmental **problems** in mainstream debate (Hickel and Kallis, 2019; Stoknes and Rockstrom, 2018). The core idea of the concept of green growth can be **summarised** as “an increase in economic output that lowers total environmental footprint” (Stoknes and Rockstrom, 2018: 42). However, just lowering the total environmental footprint might not be enough to stay within planetary boundaries, and Stoknes and Rockstrom (2018: 41) have, consequently, introduced the concept of ‘genuine green growth’, which refers to “suﬃcient decoupling to achieve science based targets for planetary boundaries”.

In parallel to the emergence of the concept of green growth, a contrasting **idea** that is questioning the hegemony of the growth paradigm has gained increasing ground under the term of ‘degrowth’ (Flipo and Schneider, 2015; Jackson, 2019). The degrowth literature is questioning the plausibility of the idea of decoupling economic growth from resource-use and the emission of GHGs, arguing that sufficient decoupling has never been achieved historically, and is unlikely to be achieved in the future given the monumental technological developments that would be required to reduce the material- and carbon-intensity of the global economy to the extent necessary (Jackson, 2009). Consequently, it is argued that the global economy cannot keep growing if we are to remain within planetary boundaries and avoid catastrophic climate change and ecological collapse, and that we need to reduce the size of the global economy rather than continue to expand it. **It is important to highlight that economic degrowth is not understood as a goal in itself, but as an inevitable consequence of the necessary reductions in material and energy throughput in the economy (Kallis et al., 2018).** These degrowth scholars argue that the focus on, and support for, green growth is politically motivated rather than scientifically supported as economic degrowth would be far more difficult to gain political support for than green growth, given that it would require an end to neoliberal capitalism (Anderson, 2015).

If we are to avoid transgressing the planetary boundaries and destabilising the ES, it is imperative to answer the question regarding whether genuine green growth is possible, or **realistic**, to achieve within the limited time frame available to reduce GHG emissions enough to avert catastrophic climate change. If this is not the case, the political focus on green growth is severely misguided, and urgently needs to be redirected to prepare society for a no-growth or degrowth future. This paper aims to contribute to the green growth-degrowth debate, by attempting to answer the question “is genuine green growth possible?”, focusing on the possibility to decouple economic growth from the emission of CO2[[1]](#footnote-1).

The paper will proceed as follows: I will begin by providing an overview of the concept of economic growth and the factors that drive it, in order to provide a clear foundation for the following discussion regarding green growth. I will thereafter provide a historical overview of the evolution of the economy-environment debate; define the concepts of ‘green growth’ and ‘genuine green growth’ in more detail; and present some of the arguments in favour of green growth. The following section will discuss some theoretical issues regarding green growth. Following, I will explore whether genuine green growth has ever been achieved historically, focusing on Stoknes and Rockstrom’s (2018) recent case study about genuine green growth in the Nordic countries. I will thereafter discuss the results of a number of studies that have attempted to model whether genuine green growth is possible to achieve in the future. I will conclude that it is highly improbable that genuine green growth can be achieved. The political focus on green growth therefore constitutes an incredibly risky gamble, and the debate ought to be refocused on how to create an economy that is not dependent on continuous economic growth to be stable.

## Economic growth

In order to properly understand discussions about the plausibility of green growth it is imperative to first have a basic understanding of the concept of economic growth and the factors that drive it. As mentioned above, the size, or monetary value, of an economy is measured by its real Gross Domestic Product (GDP). Real GDP measures the monetary value of all newly produced goods and services within an economy in a given period of time, adjusted for inflation, and economic growth therefore refers to an increase in the value of all goods and services that are produced within that economy (Lipsey and Chrystal, 2015).

There exist multiple theories that attempt to explain what causes economic growth, some being focused on the supply-side and others on the demand-side of the economy. Demand-side theories focus on how increases in demands for goods and services lead to increases in production to satisfy the increased demand and, therefore, to economic growth (*ibid.*). These theories tend to relate to short-term growth, rather than long-term growth, as the ability of increases in aggregate demand to cause economic growth depends on the productive capacity of the economy to increase aggregate supply. Supply-side theories, on the other hand, are more focused on the ability of an economy to produce more goods and services through productivity improvements, which can cause long-term economic growth. The productive capacity of the economy is hence central to both demand-side and supply-side theories, and increases in aggregate supply can be achieved through two main mechanisms: by increasing the input in the economy, such as capital or the number of workers; or by increasing the productivity of capital and labour through technological innovation and improved management, to get more output for the same input (Jacobs, 2012; Flynn, 2011; Turner and Katris, 2019).

## Green growth

### History of the environment-economy debate

Although the term green growth is relatively recent, discussions related to the relationship between economic growth and the environment are not new, but can arguably be traced back to 1972 when The Club of Rome published the *Limits to Growth* (LtG) report (Ward et al., 2016). Using computer simulations, the LtG report explored the relationship between economic growth and the natural environment and argued that continuous economic growth under business as usual would result in collapse of the population and economic system by the middle of the 21st century (Turner, 2008; Ward et al., 2016). The debate about the environment-economy relationship that followed was, consequently, framed in terms of a trade-off, or a win-lose situation (Turner and Katris, 2019).

From the 1980s onwards the debate regarding the relationship between the economy and the environment began to shift, and increasingly came to be dominated by ecological modernisation theories (EMTs), that oppose the idea that this relationship necessarily needs to be understood as a trade-off, arguing instead that economic growth and environmental improvements can **occur** in tandem (Fiorino, 2018). This changing perception of the environment-economy relationship **coincided** with the consolidation of the neoliberal ideology’s rise to a globally hegemonic position, and the **related** globalisation of neoliberal capitalism and the growth paradigm (Peck et al., 2018; Fletcher and Rammelt, 2017). EMTs became central to the sustainable development agenda which emerged with, and has grown since, the publication of *Our Common Future* (also known as the Brundtland Report) in 1987, which was commissioned by the UN Secretary-General to examine the relationship between economic growth and environmental degradation (Death, 2013). The term ‘sustainable development’ was here defined as “development which meets the needs of the present, without compromising the ability of future generations to meet their own needs”, and this discourse has been central to debates about the environment-economy relationship since the publication of *Our Common Future* (Brundtland, 1987: 43)*.* It was also around this time, in the late 1980s and early 1990s, that the threat of anthropogenic climate change began to emerge on the political agenda (Bulkeley and Newell, 2015).

In the 1990s and 2000s the hypothesis of the existence of an Ecological Kuznets Curve (EKC) became a key aspect of the ecological modernisation and sustainable development discourse, and further consolidated the idea that it is possible to achieve environment-economy synergies (Turner and Katris, 2019). The EKC hypothesis **held** that environmental quality initially will decrease as an economy grows, but then begin to increase as a certain level of economic development is reached (York et al., 2010). It is argued that this phenomenon will occur through three main mechanisms: structural changes in the economy through a shift away from heavy industrial activity towards cleaner industries and service sectors; increased demand for environmental quality as individuals adopt post-material values as they become richer; and, mainly, that technological developments will lead to increased energy/material/resource (EMR) efficiency, and, therefore, lower the pressure on the natural environment (Turner and Katris, 2019; Hoffman, 2016; Franzen and Meyer, 2010). In other words, it was argued that the environmental pressures of the increased scale of economic activity could be outweighed by composition and technique effects that lowered this pressure, and that economic growth and environmental degradation could be decoupled (Hoffman, 2016; Fletcher and Rammelt, 2017). This idea of scale vs composition and technique effects remains central to the ‘green growth’ discourse.

### The green growth paradigm

Although clearly latent in these earlier discussions about the relationship between the economy and the environment, the term green growth first emerged during the first decade of the 21st century and **then** became a central theme on the international agenda at the Rio+20 Conference in 2012 (Hickel and Kallis, 2019; Fiorino, 2018; Dale et al., 2016; Hoffman, 2016; Wanner, 2015). The emergence of the concept at this specific time can be explained **with** reference to two main phenomena: the increasing recognition that the historical, brown growth path is unsustainable in combination with the growing concern about anthropogenic climate change; and the increasing questioning of neoliberalism resulting from the 2008-2009 global financial crisis (Fiorino, 2018). As expressed by Dale et al. (2016: 5), it was “when the neoliberal paradigm appeared to wobble, in the early 2000s and then egregiously in the wake of the global economic crisis of 2008, that the green growth idea arose”. Green growth may therefore fruitfully be understood as a neoliberal ‘self-reinvention’ to give the neoliberal growth paradigm renewed legitimacy in light of the financial crisis and the escalating environmental crisis (Dale et al., 2016**).**

Although closely linked to the idea of sustainable development and EMT, the green growth agenda has even stronger links to the neoliberal economic paradigm and its belief in the primacy of the market. In fact, climate change has increasingly come to be perceived in terms of a ‘market failure’, caused by the externalisation of the environmental costs of production from the price of goods, which makes it impossible for otherwise rational consumers to make rational decision (Stern, 2007; Epps and Green, 2010; Storm, 2017). Following from this understanding of the problem of climate change, the proposed solutions are similarly framed in relation to the realm of the market, and the internalisation of environmental costs through carbon-pricing is central to the green growth agenda (Andrew et al., 2010; Fiorino, 2018). As expressed by Fiorino (2018: 134), the “preference for market-like mechanisms is a defining feature of green growth”. By internalising the environmental costs of production into the price of goods and services, it is argued that rational consumers will change their behaviours and shift their consumption towards less carbon-intensive sectors, contributing to altering the composition of economic activity (Storm, 2017). Similarly, producers will be incentivised to increase their carbon- and energy-productivity through technological innovation, and techno-optimism is central to the green growth agenda (Mitchell, 2012; Bowen, 2019). The mechanisms through which it is argued that green growth can be achieved are discussed further in a later section.

Building on the earlier **ideas** from EMTs and the EKC hypothesis regarding the possibility to decouple economic growth from environmental degradation in a win-win situation, the green growth discourse additionally argues that shifting to a low-carbon economy and ‘going green’ can be “an economic opportunity” as new, green markets emerge (Dale et al., 2016: 4; Bulkeley and Newell, 2015). In other words, the green growth argument does “not only insists on [the compatibility of economic growth and environmental protection], but claims that protecting the environment can actually yield better growth” (Jacobs, 2012: 6). By increasing EMR efficiency it is argued that the money that is saved through these efficiency increases can be spent in a more productive way, and therefore contributing to economic growth. Moreover, it is increasingly recognised that the economic costs of unabated climate change far outweigh those of tackling climate change, and climate action has, as a result, come to be understood as a pro-growth strategy (Jacobs, 2012; Stern, 2007; Fouquet, 2019). Green growth therefore “allows environmental protection to be cast as a question of opportunity and reward, rather than costly restraint”, making it much more attractive politically (Bowen and Fankhauser, 2011: 1157; Capasso et al., 2019).

Support for the concept of green growth has grown massively over the past decade, and ‘green growth’ is today being promoted by major multilateral organisations such as the Organisation for Economic Co-operation and Development (OECD), United Nations Environmental Program (UNEP), and the World Bank, as well as by governments all over the planet (Victor and Sers, 2019; Hickel and Kallis, 2019; Stoknes and Rockstrom, 2018; Jacobs, 2012; van Vuuren et al., 2017; OECD 2011; UNEP, 2011; World Bank, 2012). The “endeavour to decouple economic growth from environmental degradation” through improved “global resource efficiency in consumption and production” is moreover included in the UN’s Sustainable Development Goals (SDG) from 2015 (United Nations, 2019). Despite the substantial focus on and support for green growth, most definitions of the concept tend to be **quite** vague, and there does not exist a universally agreed upon definition (Victor and Sers, 2019). The World Bank refers to green growth as “growth that is eﬃcient in its use of natural resources, clean in that it minimizes pollution and environmental impacts, and resilient in that it accounts for natural hazards” (2012: 2). UNEP (2011: 16) instead states that green growth leads to “improved human well-being and social equity, while signiﬁcantly reducing environmental risks and ecological scarcities”; whilst the OECD (2011: 18) argues that the concept of green growth is about “fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies”. Common to all definitions of green growth, however, is the idea that it is possible to ‘decouple’ economic growth from increased environmental pressures and EMR-throughput in the economy through increased EMR-productivity, or, inversely, decreased EMR-intensity, and achieve non-material economic growth (Hickel and Kallis, 2019; Fletcher and Rammelt, 2017). In relation to anthropogenic climate change this would translate into increasing the carbon productivity ($/kgCO2) of the economy, so that more **economic** value can be produced per unit of GHG that is emitted.

### Decoupling and genuine green growth

Decoupling of GHG emissions from economic growth can be either relative or absolute, and it is imperative to differentiate between the two (Victor and Sers, 2019; Fletcher and Rammelt, 2017). The former refers to a situation in which the carbon productivity of economic activity is improved, but at a lower rate than the size of the economy increases, with the net-effect being a total increase in GHG emissions as the scale of economic activity outweighs the changes in composition and technique. In other words, it can be understood as a “gain in efficiency rather than removal of the link between [GHG emissions] and GDP” (Ward et al., 2016: 2). The latter, on the other hand, is achieved when the carbon-productivity is increased at a sufficient rate to outpace the rate of economic growth, resulting in absolute reductions of total GHG emissions. Achieving green growth would require absolute decoupling of economic activity from GHG emissions, and “relates to the rate of change in [carbon-productivity] relative to the overall growth rate of the economy” (Stoknes and Rockstrom, 2018: 42; Hickel and Kallis, 2019; Ward et al., 2016).

However, even if the carbon productivity is increased enough to achieve absolute decoupling of economic grow from the flow of GHGs, it is still not certain that this decoupling is enough to limit global warming to 2C or 1.5C (Stoknes and Rockstrom, 2018). This is a **result of the fact that the** **issue with** global warming is not mainly one of *flows* of GHGs, but of the accumulating *stock* of GHGs gases in the atmosphere resulting from these flows (Victor and Sers, 2019). In a scenario in which carbon productivity increases at a rate of 4% per year (pa) and the economy grows by 3% pa, absolute decoupling will have been achieved, and emissions will be reduced by approximately 1% pa.However, as emissions need to be reduced by 6.8% (4%) pa to limit global warming to 1.5C (2C), a decoupling rate of 10.5% (7.3%) pa would be necessary if the economy grows at a rate of 3% pa (Hickel and Kallis, 2019)[[2]](#footnote-2). Although economic growth is absolutely decoupled from GHG emissions in the scenario above, and green growth therefore arguably has been achieved, the decoupling rate is insufficient to cut emissions enough to achieve genuine green growth and stay within the remaining carbon budget.

### Achieving (genuine) green growth

As discussed above, the core idea of green growth arguments is that it is possible to outweigh the environmental impact of the increasing scale of economic activity by altering the composition of the economy and increasing its EMR-efficiency and carbon-productivity through technological development. In relation to the threat of climate change this mainly translates into decoupling economic growth from the production and consumption of fossil fuel energy, which is responsible for approximately 70% of all GHG emissions (Pollin, 2018). In addition, it would be necessary to substantially reduce the emission of GHGs from the Agriculture, Forestry and Other Land Use (AFOLU) sector through afforestation and dietary changes, and switch to alternative industrial processes that emit less GHG emissions (Rogelj et al., 2018; Rockstrom et al., 2017).

Given that such a large proportion of GHG emissions come from the combustion of fossil fuels for energy, the decarbonisation of the economy can largely be understood as a two-pronged process of decreasing the energy-intensity of economic activity and decreasing the carbon-intensity of energy. In other words, the relationship between economic activity (Y) and carbon emissions (C) can be decomposed in two links: the energy-intensity of the economy (E/Y) and the carbon-intensity of energy (C/E) (Deutch, 2017). Reducing the latter would be achieved through **substitution of fossil fuel energy for renewable energy**. Reduction of the former can be decomposed into decreasing the energy-intensity on both the production-side and the consumption-side of the economy, by increasing the energy-efficiency of industrial processes through technological developments, and by reducing the need for energy of households through, for example, improved insulation of houses or increased energy-efficiency of cars, respectively (Turner and Katris, 2019; Pollin, 2018). In relation to energy-efficiency improvements on the production-side of the economy it is argued that these will lower the marginal costs of energy services, therefore lowering output prices, boost economic productivity and, consequently, cause economic growth (Turner and Katris, 2019). This follows **directly** from the previously discussed mechanism through which economic growth is achieved. It is also argued that the savings resulting from energy-efficiency improvements can be spent on more productive sides of the economy, which, similarly, would cause economic expansion (Jacobs, 2012). In relation to energy-efficiency improvements on the consumption-side, it is suggested that these will free up money that can be spent on other goods and services which might cause economic growth, similar to the latter mechanism described for the production-side. As mentioned above, one of the core approaches to achieving decoupling and genuine green growth is to introduce a carbon price to correct the current ‘market-failure’ (Pollin, 2018; Bulkeley and Newell, 2015). The idea is that such a carbon price will alter the composition of the economy in favour of less carbon-intensive goods and services as consumers are incentivised to switch their consumption to low-intensity goods and services, as well as increase the energy-efficiency of the economy as producers are incentivised to invest in energy-efficiency improvements.

Another pro-green growth argument is that the necessary changes to decarbonise the economy will require vast growth in low-intensity sectors and substantial infrastructural changes which also will result in increased employment, and economic growth. The increases in numbers of jobs would be a result of how a ‘green’ economy would be more labour-intensive than the existing fossil fuel-based economy (Pollin, 2018). Furthermore, it is argued that a growing economy will make it easier to carry out the necessary mitigation activities as more money will be available to invest in raising energy-efficiency standards and expanding the renewable energy supply (Pollin, 2018). This is a result of the fact that if a constant percentage of GDP is invested in activities aimed at decarbonising the economy, it is obvious that the absolute size of these investments will increase as the economy grows.

## Theoretical issues with genuine green growth

There exist a range of theoretical issues regarding the plausibility of achieving genuine green growth and the arguments about how it can be realised. As mentioned, energy efficiency improvements, shifts to renewable energy, and **substitution of carbon-intensive goods and services for low-intensity goods and services** are the main channels through which it is argued that genuine green growth could be achieved. This section will discuss each of these suggestions and highlight their problematic **aspects.**

### Energy efficiency

* Rebound (money savings from energy efficiency increases are spent elsewhere…) as as industries become dematerialised, life-styles tend to become increasingly materialised (I and F 2014)
* Projected increased energy demand (Ward et al., 2016)
* It is not necessarily the case that the saving on other goods and services will cause further growth. Although it should be recognised that the savings resulting from energy-efficiency improvements would likely raise living standards for less-advantaged households, as more of their income could be spent on other goods.

As discussed, perhaps the main suggested driver of genuine green growth is improving the energy efficiency of the economy. This

### Renewable energy

* EROI
* something about the ability of renewables to generate this amount of energy
* energy-emission trap?

As fossil fuel energy is the main source of CO2 emissions, it is “possible to envisage a scenario in which GDP growth is decoupled from the use of fossil fuels and related CO2 emissions by switching to 100% renewable energy” (Ward et al., 2016: 3). The question is whether such a transition is realistic under the assumption of continuous economic growth, and the related increasing demand for energy services.

### Substitution

Selective growth and selective degrowth

As 70% of GHG emissions are caused by the combustion of fossil fuels for energy, it is theoretically possible that carbon-intensity could fall continuously if we were to switch to 100% renewable energy.

“The consumption of oil, coal and natural gas will also need to fall by about 35 per cent over this same twenty-year period—an average rate of decline of 2.2 per cent per year” (Pollin, 2018: 10)

* See Fletcher and Rammelt!

I agree with Pollin (2018) in his discussion about ‘*Degrowth vs a Green New Deal*’ in that “addressing these matters [regarding selective growth and selective degrowth] in terms of their specifics is more constructive in addressing climate change than presenting broad generalities about the nature of economic growth, positive or negative”. It is crucial to realise that the main issue in regard to the possibility of achieving genuine green growth is the net effect on economic activity following from growth in low-intensity sectors vs degrowth in high-intensity sectors. It is a shame, therefore, that Pollin (2018) himself does not follow through on this in relation to his discussion about degrowth, but assumes that economic degrowth would imply an **equal** reduction in all economic activity.

* Carbon price and its effect on markets (Kallis?) such carbon prices, which will need to “much higher than the ones observed in real markets”, and to set stringent … (Rogelj et al., 2018: 148).
* Productivity

### Conclusion

…

The following sections will explore the decoupling rates that have been achieved on a global scale, and Stoknes and Rockstrom’s (2018) recent case-study of genuine green growth in the Nordic countries will thereafter be discussed.

## Has genuine green growth been achieved?

The carbon productivity of the global economy improved steadily during the four final decades of the 20th century, at an average rate of 1.28% per annum (pa) (Hickel and Kallis, 2019). However, as the economy grew at an average rate of 3% pa, only relative decoupling was achieved, and global CO2 emissions increased dramatically during this period (Stoknes and Rockstrom, 2018). Between 2000 and 2014 the total carbon-productivity of the world economy did not improve, and emissions grew by 43% between 2000 and 2015 (Hickel and Kallis, 2019; Pollin, 2018). High-income nations did experience production-based carbon-productivity improvements of 1.61% pa, lower than their 1970-2000 average of 1.91% pa(Hickel and Kallis, 2019). In addition, Aden (2016) argues that 21 (most of them developed) countries managed to increase their carbon-productivity sufficiently to absolutely decouple economic growth from CO2 emissions between 2000 and 2014. However, it is likely that these carbon-productivity improvements were a result of the outsourcing of heavy industries to developing countries, a phenomenon which will be explored in more detail below. Some absolute decoupling was achieved in 2015 and 2016, however, as GHG emissions levelled off whilst the global economy continued to grow, but this trend has not continued, and emissions increased by 1.6% and 2.7% in 2017 and 2018, respectively (Hickel and Kallis, 2019; de Coninck et al., 2018). The decoupling rates that are necessary to limit global warming to 2C or 1.5C have hence never been achieved on a global scale, and the only periods in which CO2 emissions have fallen have been during economic recessions (Hickel and Kallis, 2019; Klein, 2014).

Rather than taking a global perspective, some studies focus on whether green growth has been achieved in specific industries, countries, or regions, arguing that such case-studies can provide evidence that green growth is possible and, therefore, might be achievable on a global scale (). One example of such a study is Stoknes and Rockstrom’s (2018) recent article in which they coined the concept of genuine green growth, and examined whether Sweden, Denmark, Finland and Norway have achieved genuine green growth during this century. I will explore this study in more detail in the following section.

### Genuine green growth in the Nordic Countries

In their article about genuine green growth in the Nordic countries, Stoknes and Rockstrom (2018) use production-based carbon-productivity data from the OECD database of green growth indicators, for the years 2000 to 2014. Based on this data they report that sufficient decoupling rates to limit global warming to 2C have been achieved in Sweden, Finland and Denmark, whereas Norway’s decoupling rate lags behind, and state that genuine green growth is “empirically possible” and that critics of green growth are wrong “in claiming that there is no evidence for genuine green growth happening since 2000” (*ibid*: 47). Their results are problematic in two main regards, however. The first relates to the rate of decoupling that is chosen as sufficient, which is far lower than what is generally deemed necessary. The second relates to their use of production-based, as opposed to consumption- (or demand-) based, data.

Stoknes and Rockstrom (2018) argue that a >2% annual reduction in CO2 emissions would be sufficient to limit increases in temperatures to 2C, relying on the higher end of the remaining carbon budget for a >66% of staying below 2C. The authors write that if the lower end of the budget was used, emissions would need to be reduced by >6% pa, and it is **somewhat** unclear why the >2% reduction rate was chosen. The choice of the 2% reduction rate is especially **surprising** given that Rockstrom (2015) previously has argued that emissions need to be reduced by 6% pa to limit global warming to 2C, and no explanation is given for his change of **opinion**. As the average global economic growth rate has been approximately 3% pa in recent decades, the authors base their estimate of the necessary carbon-productivity improvement rate (CAPRO) on this growth rate. As a result, they argue that a CAPRO of at least 5% pa is necessary to achieve genuine green growth. In addition, they analyse the reported estimates of necessary decoupling rates from 10 previous studies to support the choice of this CAPRO and argue that the average decoupling rate of these studies is close to 5% pa (see Table 1 in Appendix A). These studies differ in multiple regards, however, and although Stoknes and Rockstrom (2018: 43) admit that “different assumption models and methodologies” are used, it is not explored in what respect these studies differ, or clarified whether, or how, these differences are accounted for when the average rate of decoupling is calculated. It is noteworthy that the authors do not report what economic growth rates are assumed in the studies they base their CAPRO on, given that this vastly affects the necessary rate of decoupling. **Taken together, the reason for the low decoupling rate that is chosen is highly unclear.**

The second main issue with Stoknes and Rockstrom’s analysis is their use of production-based carbon-productivity data. Only CO2 emissions generated by domestic production are included in this measure, regardless of where the goods and services that are produced end up being consumed (OECD, 2017). This is problematic as many developed countries outsource resource- and emission-intensive industries to developing countries and increasingly focus their own economic activity on service sectors (Antal and van der Bergh, 2016; Dale et al., 2016; Hoffman, 2016; Isenhour and Feng, 2016). As a result, their consumption-based (embodied) emissions come to exceed their production-based emissions, making them net-importers of embodied CO2 (Victor and Sers, 2019). As expressed by Isenhour and Feng (2016: 321), “consumption-based emissions indicators challenge claims that economic growth and ecological harm can be absolutely decoupled”. **Almost 25% of the GHG emissions that are related to goods which are consumed in developed countries are outsourced (Hoffman, 2016).** Peters et al. (2011) show that the proportion of CO2 emissions that are embodied in international trade grew from approximately 20% in 1990 to 26% in 2008, and that net emission transfers between low- and high-income countries quadrupled during the same time. Victors and Sers (2019: 37) further state that the “net import of embodied CO2 emissions by OECD countries doubled from 1995 to 2007”.

Taking Sweden as an example of this phenomenon, Hagbert et al. (2018) report that 65% of the GHG emissions related to Swedish consumption are emitted outside of Sweden’s (**Swedish?**) territory, and therefore not included in data on Sweden’s production-based GHG emissions. Similarly, Isenhour and Feng (2016) show that although Sweden’s production-based GHG emissions are below 1990-levels, their consumption-based emissions have increased by more than 25% over the same period. Using improvements in production-based carbon-productivity as evidence that genuine green growth has been achieved in some countries, and therefore might be possible on a global scale, is highly questionable, as shifting the location of emission-intensive production elsewhere cannot be understood as a solution, given the global nature of the problem of global warming (Victor, 2012).

#### OECD Demand-based carbon-productivity data

**In their analysis** of the production-based carbon-productivity data, Stoknes and Rockstrom (2018) created an index for the carbon-productivity data, converting the average of each country for the years 2000-2003 to 100 as a baseline (data points can be found in Table 2 in Appendix A). Based on this index they thereafter produced a graph showing the annual rate of change in carbon-productivity for each country over this time period, compared to the genuine green growth curve (see Figure 1 in Appendix A). In addition, they fitted a logistic growth curve to the data for the years 2003-2014, using ordinary least squares (OLS). According to this curve, Sweden’s annual rate of change in carbon-productivity was 5.76%; Finland’s was 5.45%; Denmark’s was 5.03%; and Norway’s was 1.47%. However, Stoknes and Rockstrom do not report any further details about these estimates, such as their confidence intervals and the …, and the accuracy of these estimates is therefore highly questionable. It does moreover make it difficult to replicate their analysis. Based on these estimates, Sweden’s, Finland’s, and Denmark’s decoupling rates were sufficient to earn the label of genuine green growth according to Stoknes and Rockstrom’s criteria, but none of them reach the 7.3% decoupling rate that is argued to be required above.

Figure 1 and Figure 2 below show the carbon-productivity changes for demand-based and production-based data in the Nordic countries between 2005 and 2015, respectively. As in Stoknes and Rockstrom’s analysis, the data were converted to an index, although the average carbon-productivity for 2005 and 2006 here was chosen as the baseline, as data for demand-based carbon-productivity only were available between 2005 and 2015 (data points can be found in Table 3 in Appendix A). The ideal GGG curve begins from year 2006, as the average for 2005 and 2006 was chosen as baseline. As can be seen, the rates of change for each country differ substantially between the two graphs, and the demand-based carbon-productivity for each country improves a lot less than the production-based carbon-productivity over this period, as was expected given the previous discussion regarding consumption- and production-based emission accounting.

### Conclusion

This section has showed that genuine green growth has not been achieved historically, neither on a global scale nor in the Nordic countries (unless one chooses an exceptionally low rate of yearly CO2 emission reductions), and that much higher decoupling rates will be necessary to reach the goals set out in the Paris Agreement. However, as expressed by Ward et al. (2016:): “simplistically extrapolating historical trends is not a reliable technique for projecting future decoupling behaviour”, and the following section will therefore explore some studies that assess the possibility of limiting global warming to 1.5C or 2C whilst having a growing economy through model-based projections and quantitative global scenarios.

## Model-based projections of genuine green growth

### Integrated Assessment Models

A large proportion of the literature exploring different scenarios for limiting global warming to 1.5C or 2C uses Integrated Assessment Models (IAMs) to derive these scenarios (Rogelj et al., 2018). These models bring together insights from various disciplines to generate “‘policy-relevant’ and cost-optimised emission scenarios”, and IAMs constitute the basis of IPCC’s assessments of mitigation pathways (Anderson, 2015). The recent IPCC report on the impacts of global warming of 1.5C assessed various mitigation pathways consistent with limiting global warming to 1.5C and 2C (Rogelj et al., 2018). 90 mitigation scenarios were identified in which warming would be kept below 1.5C with no or limited temporary overshoot during the 21st century, and 132 in which peak-warming was kept below 2C, and therefore consistent with the Paris Agreement. Of the 90 pathways limiting global warming to 1.5C, only 9 limited peak warming to 1.5C (with >55% probability), whereas the remaining 81 were expected to temporarily overshoot 1.5C. Additionally, no pathways with >66% probability of keeping temperatures below 1.5C throughout the entirety of the 21st century were identified (*ibid*).

The IPCC mitigation scenarios are based on various Shared Socio-Economic Pathways (SSPs) which have rising GDP as a built-in feature, and all these scenarios can therefore be understood as genuine green growth scenarios (unless one aims for >66% likelihood of remaining below 1.5C without overshoot) (Hickel and Kallis, 2019; van Vuuren et al., 2017). However, the vast majority of these pathways depend on widespread deployment of different forms of carbon dioxide removal (CDR) technologies to remove CO2 from the atmosphere, thereby substantially increasing the size of the remaining carbon budget, and reducing the required emissions reduction rates (Rogelj et al., 2018; Hickel and Kallis, 2019). In fact, Rogelj et al. (2018: 96) write that “[all] analysed pathways limiting warming to 1.5C with no or limited overshoot use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net negative emissions to return global warming to 1.5°C following a peak”. The authors recognise that the reliance on CDR technology is problematic and constitutes “a major risk in the ability to limit warming to 1.5°C”, given that “CDR deployed at scale is unproven” (Rogelj et al., 2018: 96). Given that these limitations are recognised in the report, it is somewhat curios that the mitigation pathways are so heavily reliant on them.

The mitigation scenarios mainly rely on bioenergy with carbon capture and storage (BECCS) to achieve negative emissions, which “entails growing large tree plantations to sequester CO2 from the atmosphere, harvesting the biomass, burning it for energy, capturing the CO2 emissions at source and storing it underground” (Hickel and Kallis, 2019: 9; Rogelj et al., 2018). BECCS is perceived as a “highly speculative technology” by a large number of scientists (Anderson and Peters, 2016: 182; Hickel and Kallis, 2019; Anderson, 2015; van Vuuren et al., 2018; Pollin, 2018). Hickel and Kallis (2019: 10) argue that not only has “the viability of power generation with CCS never been proven to be economically viable or scalable”, but the plantations that would be necessary for the scale of biomass required would cover “land two to three times the size of India”. The heavy reliance on such unproven and speculative negative emission technologies to limit global warming is therefore highly problematic, and it is highly questionable whether it can be justified to rely on such technologies to support the plausibility of genuine green growth.

### Empirical models excluding BECCS and other CDR technologies

As a result of the widespread criticisms of BECCS, the 2018 IPCC report included one mitigation scenario that limits global warming to 1.5C without relying on negative emissions technologies (Rogelj et al., 2018; Grubler et al., 2018). This scenario is known as ‘Low Energy Demand’ (LED), and it achieves sufficient emission reductions by modelling that energy demand is reduced by 40% by 2050, and total material output (i.e. production and consumption) is reduced by 20% (Grubler et al., 2018). This, in turn, is achieved through a combination of improvements in efficiency and dematerialisation, accomplished by “shifting away from private ownership of key commodities (like cars) towards sharing-based models” (Hickel and Kallis, 2019: 12). Projecting economic growth of approximately 2% pa, this scenario is a genuine green growth scenario. However, Hickel and Kallis (2019) highlight that the model used to estimate the GDP growth in the LED scenario calculates the growth rate using only labour productivity and energy as inputs, and therefore is insensitive to reductions in material production and consumption. Given that GDP measures the value of the goods and services that are produced within an economy, it is highly questionable that GDP growth of 2% pa is achievable given such vast reductions in material production and consumption. No evidence is provided for the feasibility of such economic growth in combination with these reductions in material output, and the IPCC report later states that “[the] literature on strategies to reconcile low-carbon trajectories with sustainable development and ecological sustainability through green growth, inclusive growth, de-growth, post-growth and development as well-being shows low agreement” (Roy et al., 2018: 470).

Other studies that model future scenarios without relying on BECCS are not very promising either. In their 2018 study of pathways to limit warming to 1.5C, Van Vuuren et al. created a scenario with rising GDP growth; a peak in global population at 8.4 billion people in 2050, followed by a decrease to 6.9 billion by the end of the century; a variety of mitigation strategies such as carbon pricing; shifts to the most efficient industrial processes for steel and cement production; substantial dietary changes with 80% reduction in meat consumption by 2050. Their results show that continuous economic growth push CO2 emissions to exceed the remaining carbon budgets for 1.5C as well as 2C, unless CDR technologies are used. Schandl et al. (2016) similarly model a scenario with aggressive mitigation policies and highly optimistic technological efficiency improvements, for which they provide no evidence as regards their feasibility. As in the study by van Vuuren et al. (2018) their results show that the remaining carbon budgets are exceeded with economic growth.

Furthermore, Hickel and Kallis (2019) assess the plausibly of achieving genuine green growth by discussing projected rates of decoupling, and show that best-case projected decoupling rates range from approximately 3% pa to 4% pa. Given that emissions need to decrease by 6.8% pa or 4% pa for a >66% chance of limiting global warming to 1.5C or 2C, respectively, the projected decoupling rates suggest that only by limiting the economic growth rate to 0% pa is it feasible to limit warming to 2C. Without economic degrowth is thus appears to be impossible to limit global warming to 1.5C.

#### Arithmetic sense check

Although not based on empirical modelling, it is illuminating to also discuss Anderson’s (2015) ‘arithmetic sense check’ based on the remaining carbon budget reported in the IPCC’s Fifth Assessment Report (AR5) from 2014. Without relying on CDR to expand this budget, the IPCC reported that 1,000 GtCO2 could be emitted between 2011 and 2100 for a >66% chance of limiting global warming to 2C. As CO2 emissions from energy had totalled around 140 GtCO2 between 2011 and 2014, Anderson estimated that the remaining budget for CO2 emissions from the energy sector, deforestation and industrial processes such as cement production was approximately 860 GtCO2 in 2015. Adopting “the IPCC’s most ambitious deforestation pathway”, the remaining budget for this sector is estimated as 60 GtCO2, and based on “[provisional] and highly optimistic analysis of recent process emissions trends” it is estimated that emission from cement production can be limited to 150 GtCO2 (Anderson, 2015). The total carbon budget for energy-only emissions between 2015 and 2100 is therefore only about 650 GtCO2 and Anderson argues that this would require emission reduction rates of 10% pa after 2025. In a scenario with 0% annual economic growth this would require a 10% decoupling rate, which is far beyond the projected decoupling rates discussed above.

#### Selective growth and selective degrowth

Another way to **approach the discussion about the plausibility** of achieving genuine green growth is to consider the question of green growth as one regarding the net-effect of growth of less carbon-intensive sectors and degrowth of more carbon-intensive sectors. In his scenario analysis of the Canadian economy Victor (2012) explores the effect of selective growth of low-intensity commodities, and selective degrowth of high-intensity commodities on GHG emissions. Assuming an economic growth rate of 3% pa, and that expenditure on high-intensity commodities decreases to 0% between 2010 and 2020, his results show that emissions decrease as the proportion of expenditure on high-intensity commodities is reduced but begin to increase again when this substitution is completed, causing cumulative emissions to exceed the carbon budget. If the carbon-intensity of these low-intensity commodities was continuously reduced, it is possible that emissions could continue to fall further, but Victor’s study clearly highlights the limits of substitution between high- and low-intensity commodities.

### Conclusion

This examination of model-based projections regarding the plausibility of achieving genuine green growth paints a bleak picture. Unless one accepts the substantial risks of relying on the hope that negative emission technologies such as BECCS will become practically and economically viable on a large enough scale, it appears impossible to stay within the remaining carbon budgets whilst the global economy grows. LED is the only model **whose** results support the plausibility of genuine green growth, but, as mentioned, no evidence is provided regarding the feasibility of the estimated growth rate. These results hence cast further doubt on the possibly of achieving genuine green growth.

## Conclusion

1. I will focus on CO2-emissions rather than GHG-emissions in general, as the former accounts for xx % of GHG-emissions, in terms of its contribution to global warming [↑](#footnote-ref-1)
2. The rate of decoupling = GDP growth rate/ (1 - rate of necessary emissions reductions) (Hickel and Kallis, 2019). [↑](#footnote-ref-2)