GROWTH IN TRANSITION

BACKGROUND REPORT

TOWARDS A SOCIO-ECOLOGICAL TRANSFORMATION OF THE ECONOMY

Background report for the Growth in Transition Conference
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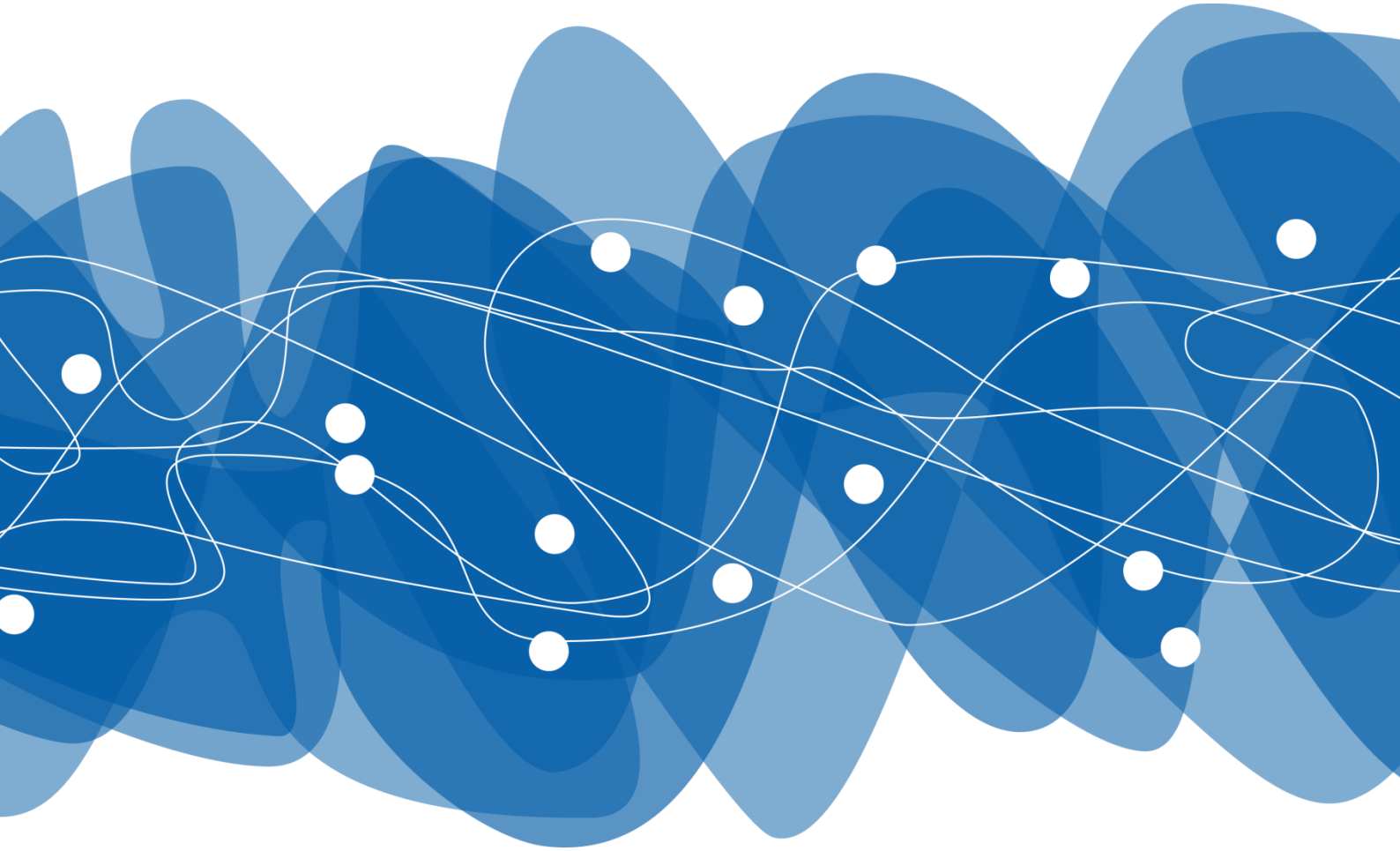

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The Initiative Growth in Transition, which was launched in 2008, brings together transformation activists and decision makers from politics, science, the economy and civil society and promotes dialogue and an exchange of perspectives on growth, prosperity and quality of life. It provides an international platform which aims to address questions of growth and an alternative, sustainable economy. The initiative is organised by the Ministry for Sustainability and Tourism.
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EXECUTIVE SUMMARY

An interdisciplinary frame for understanding the economy-environment-relationship

By 2018, Sustainable Development has been established as a global general principle for virtually every realm of society. Inter- and intra-generational equity and the balance between social, ecological and economic goals are not only cornerstones of environmental and development policies, but also accepted in fields such as economic policy, education and technology development. The most prominent manifestation of this process was the adoption of the Sustainable Development Goals (SDGs) in 2015.

Since the Rio+20 summit in 2012, "Green Growth" and the "Green Economy" have become paradigmatic terms for how to achieve wealth and wellbeing and at the same time save the planet. They are based on the assumption that technology can "decouple" economic output from the use of resources. On the one hand, the green growth paradigm states that intra-sectoral technical change can contribute to higher efficiency in the use of natural sources and sinks. On the other hand, the concept also stresses the need for an inter-sectoral change – a shift in the importance of different sectors towards those sectors that are using cleaner technology and helping to reduce environmental impacts. However, there is no empirical evidence whatsoever yet that efficiency improvements, such as the ones that would be required to respect the 2°C objective or to achieve absolute decoupling, have been achieved with continuous growth.

This problem has contributed to the rise of lines of thought known as "post-growth" or even "de-growth". Both paradigms stand for a fundamental rethinking of the purpose of economic growth resulting from a deep scepticism towards green growth, often accompanied by doubts regarding the social and cultural consequences of economic growth that are assumed to be positive. While the majority of economists points to the difficulties of managing a stagnant or shrinking economy, the ecological case for dismissing the ubiquitous goal of economic growth is a strong one both for theoretical and empirical reasons.

The challenge of global sustainable development is sometimes conceptualized as a choice between "change by design" (or "managed transition") and "change by disaster (or "forced transition"). The upshot is that there is a very high probability that change will come: either forced change or managed change. It is clear that the relationship between economy and environment is crucial for the socio-ecological transformational challenges ahead. Social as well as ecological issues are intimately linked to economic issues such as growth, efficiency and distribution.

Obviously, understanding the economy-ecology relationship is of utmost importance when the challenges of sustainability, transformation and quality of life are to be well managed. Towards this end, this report contains an elaboration

of the state of knowledge, research challenges and possible political implications in six selected fields of key importance for realising a successful transformation: (1) Sustainable natural resource use, (2) Macroeconomics and the environment, (3) Finance and sustainability, (4) Sustainable Consumption and Production, (5) Sustainable work, and (6) Transformative learning. The authors are well aware that even though a wide range of topics is tackled, the elaborations are far from covering all relevant topics to be considered in a socio-ecological transformation. However, in describing the relationship between economy and environment along the lines of the work of the Institute for Ecological Economics at the WU Vienna, the following pages reveal the complexity of the challenges ahead.

Sustainable natural resource use

Due to the growth of world population, continued high levels of consumption in the developed world and the rapid industrialisation of emerging economies, worldwide demand for natural resources such as raw materials, energy, water and land is steadily increasing. As a consequence, renewable resources and the ecological services they provide, such as clean water or a stable climate, are at great risk of degradation and collapse (UNEP, 2012).

While early approaches of resource governance have mostly focused on one single environmental category, such as energy or greenhouse gas emissions, it is now generally agreed that a socio-ecological transformation requires a systemic perspective, taking into account the interrelations between different types of natural resources. This approach is termed the "nexus perspective" and integrates the dimensions of materials, energy, water, land and food (Bleischwitz et al., 2018).

Since 1970, in 45 years, global raw material extraction has increased more than threefold, reaching almost 90 billion tonnes in 2015. The boost in global raw material extraction in particular since the 1990s was mainly driven by the rise of emerging economies such as China and India, where raw materials were used to fuel the rise of the national economy as well as to produce a wide range of products for the global economy.

Global raw material extraction is thus not only driven by national demand for industrialisation and production. Today more than ever, trends in resource use are reflecting the unprecedented grade of globalisation and international trade as its most important component. Resource-rich countries or regions – often located in the Global South – sell their resources to those with scarce availabilities, but high affluence and resource demand. For many of the extracting countries, the raw material exports are the main source of income, while those with small resource endowments increasingly depend on imports from abroad.

While exporters benefit in economic terms through realising export revenues from selling raw materials, they have to cope with environmental and social impacts related to resource extraction activities, such as environmental degradation, water scarcity and pollution, child labour, etc. Hence, importing resources from abroad is not only a strategy to deal with resource scarcity, but also a way to outsource the undesirable consequences of resource extraction and processing.

Asia is a very important provider of resources of all types, as well as one of the main final consumers. In recent years, countries like China have experienced a shift from being a net-exporter of raw materials to becoming a net-importer. This is a pattern that in general is typical for Europe. Due to its limited resource endowments, Europe outsources resource extraction (and emissions) to other countries, resulting in higher values for consumption than for extraction. In contrast, Latin America provides its resources to the global market. Especially in the case of raw materials (and here especially with regard to metals), the region has a considerably larger share in global extraction than in consumption.

One of the currently most prominent political concepts in the context of sustainable resource management is the concept of "decoupling". It aims at detaching a positive trend – economic growth, which is commonly regarded as the most important driver for employment and prosperity – from resource use and related environmental impacts. It is precisely for industrialised countries with their high levels of per-capita consumption that absolute decoupling is a necessary goal, to relieve pressure on the environment on one hand and to allow for an increase in resource use by developing countries on the other hand.

Globally we are living in an era where resource use and GHG emissions are steadily increasing. In the case of raw materials, the world is even in a phase of "re-coupling", where relative decoupling trends stopped around the turn of the millennium and resource use is now growing faster than the economy. The empirical trends show that there is an urgent need to develop and implement an ambitious policy framework to reverse current trends of increasing resource use. In recent years, European resource policy has focused increasingly on the concept of a "circular economy", which aims at closing the loops of raw material use and thereby reducing the demand for virgin raw materials. The objective is to achieve a decoupling of economic development from raw material use.

However, some key elements required for a transition towards an economy with significantly lower inputs of natural resources, i.e. those that prevent the trespassing of planetary boundaries with possibly irreversible ecological damage and social implications, are currently missing: (1) There is an urgent demand for setting ambitious targets for a reduction of natural resource use, in particular in countries with high per-capita consumption levels; (2) An overarching strategy to use the price mechanism for triggering a long-term change should be pursued. Increasing prices of natural resource use should be integrated into a broader redesign of the tax system as part of an environmental tax reform (ETR); (3) International trade could contribute to a reduction of resource use if products were produced in those countries that require the smallest amounts of natural resources, and if products were exchanged afterwards (Dittrich, 2007).

A policy environment supporting a socio-ecological transformation could therefore lead to a regionalisation of material cycles for some products, such as agricultural products or wood for construction purposes. At the same time, circular economy measures, such as increasing recycling rates for metal ores, could help close the loops for materials that are not available in a country or region and thus decrease dependency on foreign and potentially unstable supplier countries.

One of the most prevalent research areas is the investigation of environmental impacts of natural resource use. The ERC project "FINEPRINT", currently carried out

at the WU's Institute for Ecological Economics, is devoted to assessing material footprints of consumption and the related environmental and social impacts with a high geographical resolution (see www.fineprint.global). Also, improving data and methods to assess the transition towards a circular economy is of utmost importance. Advancement of knowledge is required with regard to the accumulation of resources in stocks within the economy, as well as the generation of waste and secondary resources use and the quantification of physical stocks within society. Finally, the integration of detailed environmental data and resource footprint models into state-of-the-art economic modelling approaches, such as Stock-Flow-Consistent Models, is one of the potential routes that is currently being explored by the research community.

Ecological macroeconomics, growth and the environment

The world is facing a triple crisis: ecological deterioration and climate change, increasingly unequal distribution of income and wealth in a continuously globalising world, as well as financial upheavals and recurring economic recessions (Naqvi, 2015; Rezai and Stagl, 2016). Ecological macroeconomics demonstrates how these crises are interconnected and related to each other. As such, it provides a holistic approach that takes the tension between the economic, ecological, and social spheres into consideration. In other words, the ecological question cannot be analysed without also looking at the social and economic dimensions. Viewing them in isolation bears the danger of generating feedback effects that might lead to increased inequality or financial upheaval. Hence, the research agenda of ecological macroeconomics is concerned with analysing the role of income distribution and finance with respect to climate change and other ecological issues.

Ecological economics considers the economy embedded within society, which itself is embedded within the environment. Several crucial aspects need to be addressed and reconciled within ecological macroeconomics: First of all, the environment and the distinct contemporary challenges (e.g. greenhouse gas emissions, resource use) need to be acknowledged as a binding constraint towards infinite economic expansion. Second, inequality and distribution, as important indicators of well-being, should receive a prominent role in the evaluation of policies. Third, finance and financial stability, as a means of enabling or constraining socio-ecological transformations, need to complement the economic analysis. Fourth, an international perspective that incorporates trade, migration, global value chains and carbon leakages is essential when analysing policies in a world that becomes increasingly globalised. Fifth, the drivers of technical change and innovation that could play an important complementary role in tackling the global ecological crisis and shaping social structures and network relationships need to be understood. Finally, and linked to the other aspects, the growth imperative requires an analysis of the necessities and benefits of, as well as the alternatives to, economic growth for human well-being. Analysing and examining these aspects constitutes the core of the research agenda of ecological macroeconomics.

For addressing these aspects, the ecological economics modelling discourse draws on the Post-Keynesian and classical economics principles of fundamental un-

certainty. It highlights the role of inter-institutional interactions, path-dependencies, availability of finances and regulation restrictions, which, if acknowledged, result in different policy outcomes than market-based solutions usually proposed by standard models (Fontana and Sawyer, 2016; Monasterolo and Raberto, 2017; Rezai and Stagl, 2016). To present the reader with a sketch of concrete modelling methodologies, the report introduces two innovative and promising modelling approaches for coping with the above stated challenges: stock-flow consistent and agent based models.

Stock-flow consistent models (Godley and Lavoie, 2012) explicitly depict stocks of money and several other financial assets and liabilities of multiple sectors in the economy, as well as flows between these sectors, thereby accounting for their dynamic interactions in a consistent accounting structure. They are usually represented by categories of the national system of accounts, usually broken down into Households, Financial and non-Financial Institutions, Government, Central Banks, and the Rest of the World.

Agent based models (ABM) are a bottom-up methodology, where the interaction of individual agents results in meso-macro outcomes that can further feed back on the economy, resulting in endogenous path-dependent outcomes. By reflecting the macro outcomes of the interactions of individual agents, ABMs reflect the famous statement of Aristotle that the whole is more than the sum of its parts. ABMs can be applied as an extension of stock-flow consistent models, where the stock-flow consistent norms can be imposed on a large set of heterogeneous agents within each sector class.

Different policy options can be examined within the model framework and the results can be compared. On that basis, an evaluation with respect to a certain policy, say a carbon tax, is possible. As a specific characteristic, the models usually allow an evaluation of these policies based on various ecological, social and economic grounds that go beyond GDP, normally considered as the core indicator representing well-being.

Current relevant research topics include models that address some of the above-identified crucial aspects for ecological macroeconomics: technological change, inequality and distribution, trade and migration, and finance and financial stability. The research described in this report is relevant for various policy areas ranging from central banking and financial stability boards to ministries of environment and sustainability, trade and economic affairs, labour, innovation, and research and development.

The research field has a strong science-policy interface character, implying that the projects aim to inform and support policy-makers by pointing out synergies, trade-offs and uncertainties that come along with various policies. For the socio-ecological transformation to become a success, a new paradigm for analysing and coping with the contemporary global policy challenges – one that views social, economic and ecological issues as interrelated - is required.

Current and future research focusses on (1) contributing to a conceptual development of ecological macroeconomics that entails the above-mentioned characteristics, (2) applying that systemic lens to aspects of environment and resource use, inequality and distribution, finance and financial stability, trade and migration and

technological change, and (3) answering concrete research questions and coping with today's environmental challenges in order to provide concrete policy recommendations without being policy prescriptive.

Finance and sustainability

Finance plays a central role in the functioning of modern societies, for better or worse. On the one hand, having access to finance is a prerequisite for companies and governments to be able to invest. This, in turn, supports long-term economic development and prosperity. On the other hand, an excessive dominance of financial markets and financial motives in shaping economic dynamics can make the economy and societies more vulnerable to crises and more prone to income and wealth inequality, as the aftermath of the 2008 financial crisis has shown. Finding the right balance in the interaction between the real and financial dimensions of economic systems is essential for guiding societies onto the path of sustainable prosperity.

The role of the financial system is also fundamental for the transformation to a low-carbon economy. Given the magnitude of the socio-economic and climate challenges ahead, this has been increasingly acknowledged by academics, policy-makers and financial stakeholders. An explicit reference to the need of financial flows "consistent with a pathway towards low greenhouse gas emissions and climate-resilient development" has been introduced in the Paris Agreement (UNFCCC, 2016).

Two main aspects should be considered: (1) First, moving to a sustainable economic system requires large-scale investments, especially in the sectors of energy, transportation, industry, and construction, and (2) a too-late-too-sudden low-carbon transformation might itself create risks for economic and financial stability, for instance in the form of stranded physical and financial assets.

A first way to fill the large investment gap is to employ public finance in the form of government spending, lending from development banks or international development aid. However, a number of obstacles are currently preventing public finance from being scaled up, such as public spending constraints either due to the high costs of accessing finance on international markets or due to tight budget constraints and austerity measures (Gottschalk and Poon, 2018). International aid flows have never gotten close to providing the required finance (OECD, 2017) and the action of development banks has been limited by their inability to create credit autonomously, as well as by the conservative management of their leverage ratio (Humphrey, 2015). Therefore, filling the SDG and low-carbon investment gap will necessarily require financial resources from private investors. In this regard, hurdles are linked to (1) the unattractive risk-return profile of many sustainable financial assets and their underlying productive activities, (2) the misalignment between the need for "patient" (i.e. long-term) finance and the short-term orientation of the financial system, and (3) the current macroeconomic context with economic activity below pre-crisis levels.

In order to overcome these barriers, academics and practitioners are discussing several solutions:

- **Pricing carbon and other environmental "bads"**
  Introducing a price that includes the use of environmental resources would modify the behaviour of consumers, firms and investors. This can be achieved through the introduction of a tax on the carbon content of goods and services or through the creation of a market of emission permits, as in the case of the European Trading Scheme, but with certain preconditions.
- **Developing new, green financial instruments**
  "Green bonds" are financial assets that are sold to finance a sustainable project. They have been the most successful among the new financial instruments. They are considered a "socially responsible promise" because they target investments in climate mitigation and adaptation.
- **Unlocking the enabling role of development banks**
  Development banks are often instrumental in funding "socially useful" activities that commercial banks are unwilling to finance because of excessive risks or low financial returns, or only willing to finance on more favourable terms. In addition to investing directly in the beneficiary countries, in particular in long-term infrastructural projects, development banks also contribute to the overcoming of market failures by developing and implementing new financial instruments (e.g. green bonds).

A socio-ecological transformation might not come without costs. Most of the debate in this area has focused on the idea that the transformation might lead a variety of assets to become "stranded", i.e. to lose value prematurely (Caldecott et al., 2016). First, a large proportion of oil, gas, and coal reserves should remain in the ground, if the Paris Agreement objectives are to be achieved (McGlade and Ekins 2015). Second, a consistent proportion of physical capital and infrastructure is directly or indirectly dependent on the use of fossil fuels and would also be negatively impacted by the transition (Campiglio ea. 2017). Third, the stranding of physical assets is likely to affect the market valuation of their owners and of their financial assets, with potential cascade effects among financial investors exposed to them (Battiston et al., 2017).

The most crucial research step to make in the near future is to develop an integrated assessment framework capable of providing a reliable quantitative assessment of the macro-financial implications of climate change and the low-carbon transition. Three interrelated areas of work can be identified: (1) empirical research aimed at identifying and quantifying the exposure of financial investors to climate-related financial risks; (2) macroeconomic modelling research aimed at analising the wider implications of climate- or transition-induced financial instability on growth, investments, employment, capacity utilization, distribution and other relevant socio-economic variables; and (3) policy analysis aimed at identifying the most effective combination of policies leading to a rapid and smooth transition to a low-carbon society, with a particular focus on the role of central banks and financial regulators.

Sustainable consumption and production

A socio-ecological transformation of the provisioning systems of goods and services that support human flourishing is necessary for preventing the negative effects of current consumption levels and production methods. The appeal and importance of research on sustainable consumption and production (SCP) lie in its tendency to consider production and consumption activities jointly. For a long time, the focus of approaches designed to mitigate climate change and reduce environmental impacts has been on improving the efficiency of production processes and developing "greener products" through ecological modernisation and technological innovation. However, while considerable efficiency improvements have been achieved over the last decades, final consumption has been increasing alongside a growing population and higher levels of affluence such that these efficiency improvements have actually been outweighed by mounting total consumption (Wenzlik et al., 2015).

In this report, the state of the art of SCP research is presented and the reader is introduced to a selection of consumer/producer driven practices that are transforming goods and services and the accompanying social arrangements. To support society in this transformation process, inter- and transdisciplinary concepts are needed to advance a systemic understanding of SCP from an ecological economics perspective:

- **SCP in the bioeconomy:**
  SCP is a frame condition for a bioeconomy transition in society. It requires a systemic understanding of complex relations between human wellbeing, the economy and the biophysical system, including the climate system. By conceptualising a bioeconomy transition as a deliberative change process, SCP strategies extend efforts to increase the "eco-efficiency" of economic output in order to move towards a more inclusive and transformative goal of "social-ecological efficiency", i.e. efforts to reduce the amount of resources and/or environmental impact related to the fulfilment of human needs in society (Kammerlander et al., forthcoming).
- **SCP in the circular economy:**
  A circular economy seeks to minimize the amount and extend the life-cycle of resources extracted from the environment and produce less waste and pollution. The adoption of the concept of a circular economy in Europe as an umbrella SCP strategy is moving forward quickly, and many SCP research strands are now connected to the circular economy.
- **The role of the consumer in SCP:**
  SCP research and policy require a synthesis and integration of economic, psychological and sociological accounts. As individual consumption patterns are embedded in social, cultural and material contexts, an integrated, systemic perspective that pays sufficient attention to power exhibited by governments, corporations and socio-cultural institutions and norms is needed (Spash and Dobernig, 2017).
- **The role of technology in SCP:**
  Modern technological infrastructure provides resources that could form the grounds for a drastically different socio-economic and political system (Srnicek and Williams, 2015; Stirling, 2015), consequently altering our consumption and production practices. Caring to whether (and how, and

where) this technological infrastructure enables the persistence of the currently dominant economic growth-driven interest, is paramount to the research on SCP.

- **The role of culture in SCP:**
  There are two facets to culture's role in SCP. First, culture, broadly defined, is the collection of beliefs and customs that influence the decision-making of human groups. Therefore, social arrangements and transportation arrangements, for example, but also consumption arrangements at the micro and macro levels, are influenced by the culture of a community. From this perspective, comprehending the impact of culture is essential for developing and analysing effective SCP initiatives.

Within these concepts, there is a wide array of specific actions individuals can undertake to reduce the impact of their lifestyles on the environment. The various strategies include changes of consumption patterns (e.g. waste prevention), changes in users' behaviour (e.g. sharing, repairing, maintaining), and changes in disposal patterns (e.g. donating, reselling, recycling) (Schanes et al., 2016b). Furthermore, new business models that consider change increasingly gain acceptance, for example circular business models for the adaptive reuse of cultural heritage sites.

Regarding the future research agenda for SCP, approaches and strategies can be contentious and are not without risk. A major concern is that "green" consumption and production might fail to slow and halt overexploitation of the planet, jeopardizing all life. An additional risk is that anthropocentric viewpoints on sustainability only focus on nature's instrumental value as material to exploit. Critical research must be the gadfly that prompts government policy and individual and collective action to prevent the unsustainable and unjust consumption that is our current legacy.

Sustainable work

Given the profound changes required to move our economy and society in a sustainable direction, the role of work in this transformation must not escape scrutiny. In sustainability research, however, the issue of work has so far been rather neglected. Public and academic discourses about work are most often limited to concerns over paid activities, i.e. employment or self-employment, or concerned with those who are defined as unemployed.

In academia, economics is the central discipline focusing on questions around the topic of work. Mainstream economic research conceptualises work in contrast to leisure. Thus, work is an activity with negative utility for which commodity consumption compensates. Economists in non-mainstream traditions have used different concepts of work, depending on the school of thought. Some consider work as any activity that creates monetary value, others as a commodity that creates economic value while being consumed; others implicitly discuss work in terms of population shares being employed or unemployed on the macroeconomic level. In many cases, there is little conceptual interest in what work actually is.

Issues such as gender or environmentally sensitive perspectives of work have so far only been addressed marginally in economics. However, these appear to be particularly relevant for conceptualising sustainable work, as they point out that work is not limited to activities that create monetary value, and that a substantive concept of work should also include unpaid activities that intentionally create socially or environmentally valuable outcomes. For measuring progress towards the goals of sustainable work, instead of GDP, employment, or the inclusion of older people in paid labour, multiple and multi-disciplinary indicators should take centre stage in order to measure a society's ability to mediate between human economic activity, society and nature – to create and regenerate socially, economically and environmentally valuable outcomes.

About 100 years ago, Keynes (1928) projected that the normal working week would be reduced to 15 hours – instead, the 40 hour workweek continues to dominate. Productivity gains have resulted in un- or underemployment or have been reabsorbed into economic growth via the creation of more work. Rising productivity, as defined by the ratio of outputs to inputs, means that the same output can be produced with less input, which implies that less labour is needed to produce the same amount of goods and services. Subsequently either additional goods are consumed, labour is shifted to low-productivity sectors, or the total number of hours worked is reduced (Jackson and Victor, 2011). If this does not take place, employees are let go. The common policy reaction is to maintain employment and reduce unemployment by instituting fiscal or monetary policies that target economic growth. At the same time, Warr and Ayres (2012) have shown that productivity growth has been based on the increased availability and use of primary resources, materials and energy. Labour productivity growth, thus, is not only tied to unemployment, but also material and resource use, implying a possible conflict between environmental and employment goals.

Sustainable work implies concerns with the mediation between humans, nature and society, as well as socially, economically and environmentally valuable outcomes. A precondition for achieving sustainable work is a sound conceptual understanding of work, where work is not only limited to paid activities and where some paid activities are excluded from being addressed in terms of work. For sustainable individual and social development, the distribution of such activities is central.

The current organisation of society is highly dependent on economic growth and thus a growth in energy and material use. Ideals such as autonomy, equality, human flourishing, and environmental sustainability are often ignored, and non-paid activities receive a subordinate amount of attention when standing in conflict with paid work. A welfare system not based on employment would help overcome these shortcomings. Overall, such a welfare system would ensure the satisfaction of needs through in-kind benefits, cash transfers and the provision of environmentally sustainable infrastructure.

Currently, the most widely debated proposal is an unconditional basic income (UBI). While UBI could relieve the pressure of people to enter wage-labour, it does not ensure that all citizens would have access to the needed services (e.g. childcare facilities), as markets do not ensure equal access to such goods. Moreover,

UBI is limited in terms of environmental sustainability, as it could drive economic growth further through increased demand.

One way to reduce the energy and material intensity of the economy would be to introduce a social-ecological tax that moves away from labour taxation and towards material and energy taxation. Such a tax could make labour-intensive services and commodities cheaper compared to goods and commodities that are energy intensive (Ayres and Voudouris, 2014; Warr and Ayres, 2012). The relative shift in prices would encourage efficiency and the development of new resource-saving technology. The policy would also increase demand for employment and possibly reduce unemployment.

Another approach that is commonly proposed is the reduction of paid employment. Working-time reduction (WTR) could lower unemployment and might result in a more equal distribution of working hours, thus mitigating the inequality issues. In addition, WTR is also discussed as a strategy to improve individuals' health and well-being. Moreover, WTR could also be a strategy to reduce environmental pressures, as fewer working hours result in lower economic output, which in turn results in lower income, consumption and resource use. However, whether such an effect would materialise depends on the overall number of working hours, which might not change if working hours were merely redistributed.

Important political and policy questions about the future of employment, as well as how to achieve sustainable work, remain. There is also undoubtedly an urgent need for further scholarship. The crucial issue and base for further research on the topic is how to move away from current unsustainable growth and work-centrism in favour of more sustainable goals, how to terminate certain fields of work (i.e. the fossil industry), how to transform the field of work, and how to create sustainable activities for people without increasing political or social instability.

Transformative learning

For the treatment of global challenges such as climate change, biodiversity loss or social inequality, education plays a central role. It has the potential to initiate and support learning processes for sustainable solutions across all SDGs. Educational pathways are socializing entire generations, shaping worldviews and values. These pathways are also crucial when it comes down to particular skills and competencies needed for the world of work – be it within companies, NPOs, NGOs, sustainability-driven entities or any other form of organisation.

One central question in this regard is what kind of education promotes the acquisition of the knowledge and skills needed to further sustainable development and to initiate and foster socio-ecological transformation. Certainly, there is awareness that it has to be education that differs from the kind provoking the current state of unsustainability.

An important starting point for understanding the concept of transformative learning is an examination of the characteristics of prevailing problems like climate change, desertification or poverty – referred to as highly complex and uncertain issues. Clearly, these issues cannot be solved by simple solutions, as multiple stakeholders are involved in producing current states of unsustainability

and often have conflicting norms, values and beliefs regarding the actual subject of transformation. That is why transformative learning strategies are essential in allowing people to understand complex systems and to engage constructively and responsibly given the increasing complexity and uncertainty of future trends.

The structural embedding and strategic implementation of transformative learning approaches into current educational institutions is challenging, however, and educational institutions struggle with integrating them into their established institutional settings. Hence, practical insights on how transformative learning can be organized, structured and institutionalized are crucial in order to provide comprehensive transformation strategies.

Transdisciplinary processes provide opportunities for collaboration between science and society, facilitating learning in different phases. Ideally such learning processes are constituted by 3 phases: joint problem framing, the co-creation of solutions and knowledge integration, and application and reflection across different fields of interest. Consequently, if universities are to fulfil their often-stated role as major driving forces of sustainable change (Scott et al., 2012), they must change their central functions and the ways they interact with the world outside of classrooms and laboratories (Lozano 2006).

In the area of teaching and learning, this transformation has started with the integration of sustainability-related topics into existing curricula (Thomas 2009). Nevertheless, in many cases, curriculum change is limited to the question of "what" to teach, but it does not sufficiently tackle the related issue of "how" to teach (Biberhofer and Rammel 2017). If universities want to provide transition arenas to foster transformative learning processes, teaching must aim at the process of transdisciplinary problem-based learning rather than the accumulation of pure knowledge (Thomas 2009).

There is also a growing tendency to transform entrepreneurial education based on the principles of Education for Sustainable Development (ESD) and transformative education in order to empower a new generation of entrepreneurs, as this is an essential perquisite of sustainable change. This shift in entrepreneurial education reflects an increasing awareness that the global challenges of the Anthropocene and their subsequent translation into the 17 SDGs require new types of entrepreneurs, as well as a - new culture of making business (Lans et al., 2014). To emphasise the implicit values that "drive" entrepreneurial creativity towards socio-ecological transformation, the RCE Vienna uses the term "sustainability-driven entrepreneurship" within this discourse. This term encompasses learning processes that encourage entrepreneurs who do not only try to reduce the negative impact of their business, but rather explicitly strive to make a positive impact on society and the planet (Dyllick and Muff, 2016).

Striving to empower a new generation of sustainability-driven entrepreneurs, more research on the supporting conditions for transformative learning environments in entrepreneurial education is needed. The transdisciplinary fundament of such learning spaces creates opportunities for responsive and transformative learning and leads to new mind-sets and competencies instead of promoting fixed behavioural responses (Krasny et al., 2010). In many cases, such new learning settings include social learning, self-organisation, reflexivity, participation and collaborative learning processes across science and society. They appear in

formal, non-formal and informal levels of education and can range from temporary and locally based service learning projects (Biberhofer and Rammel, 2017) to social initiatives like transition towns (Aiken, 2012) to new incubators for sustainability-driven start-ups like the Playpark Sachsenplatz, which is coordinated by the RCE Vienna at WU Vienna.

Facing SDG 4, policymakers are asked to understand the societal role of universities in a different light and to support conditions for transformative learning across various interfaces between science and society. This is of special importance for entrepreneurial education and for educating a new generation of entrepreneurs to drive socio-ecological transformations towards a post-growth society. This has the following policy implications: (1) Transformative learning needs to be reflected at all levels of educational policy; (2) the concept of entrepreneurial universities, as well as the purpose of entrepreneurial education, should be extended and must reflect the new culture of sustainability-driven entrepreneurs and steer away from supporting business as usual; (3) encouraging transdisciplinarity in education implies significant reform in the current educational system while emphasising the need for open dialogue and knowledge exchange across science-society interfaces; and (4) evaluation and assessment strategies for universities and research should not only be focused on learning outcomes, but must also integrate learning processes as well as the societal impact into evaluation strategies. Additionally, this orientation on impact and socio-ecological transformation should also be reflected in the related funding schemes for research and higher education.

Beyond the state of the art

The manifold and complex links between the aforementioned topics are certainly a field where more research is needed – research that must, due to the nature of the problems and issues involved, be of both inter- and transdisciplinary character. The interconnections between the topics – resource use and environmental policy, macro-economics and economic policy, the implications of climate issues for financial topics such as regulation of the financial industry, models of creating patterns of sustainable consumption and production, the challenge of sustainable work in a world shaped by technological shifts and ecological limits, and the role of learning and education for a socio-ecological transformation – deserve further research. Such research will be a highly valuable resource for the societal discourse on the transformation towards sustainable development.

1
INTRODUCTION: AN INTERDISCIPLINARY FRAME FOR UNDERSTANDING THE ECONOMY-ENVIRONMENT RELATIONSHIP

FRED LUKS

Sustainable Development as a vision for society

By 2018, Sustainable Development, defined as a development that meets the needs of the present without compromising the ability of future generations to meet their own needs, has been established as a global general principle for virtually every realm of society. Inter- and intra-generational equity and the balance between social, ecological and economic goals are not only cornerstones of environmental and development policies, but also accepted in fields such as economic policy, education and technology development.

What is more, terms like Corporate Social Responsibility (CSR), Corporate Sustainability (CS), Corporate Responsibility (CR) or Corporate Citizenship (CC) indicate that the goals of sustainable development are not only relevant for an array of policy fields, but also for the private sector. From agriculture and car producers to chemical industries and the financial sector, every field of the economy is confronted with societal demands (by the state, but also by civil society and ordinary customers and citizens) for a sustainable and therefore responsible behaviour. Hence, sustainable development has become a hegemonic concept influencing virtually all aspects of societies.

The latest of these efforts was the COP 21 of the climate convention that resulted in the Paris Agreement in 2015 and the conclusions of the General Assembly of the United Nations in the same year. The General Assembly agreed on 17 "Sustainable Development Goals" that are now infamously known as the "SDGs," including 169 sub-goals or "targets". The closely inter-linked SDGs cover virtually every field of sustainable development from the fight against poverty and hunger and the call for gender equality to an active climate polity, a rigorous protection of oceanic resources and the commitment to a global partnership in order to reach the social, ecological, and economic goals.

Austria's auditing authority – the *Rechnungshof* – has recently analysed the country's approach to the SDGs and found that there is considerable room for improvement in this important policy field. The following pages can also be read as one element of the process of developing national measures that can strengthen Austria's commitment to the SDGs and their successful implementation. What is needed, among others things, is a research approach that transcends disciplinary boundaries and that is able to promote understanding and evaluate

the relationship between economy and environment. In the context of sustainability, growth is a central topic when discussing this relationship.

Beyond "Green Growth" and "Degrowth": "Growth in Transition"

"Green Growth"

Since the Rio+20 summit in 2012, "Green Growth" and the "Green Economy" have become paradigmatic terms for how to achieve wealth and wellbeing but at the same time save the planet. They are based on the assumption that technology can "decouple" economic output from the use of resources. The idea is simple: The "Green Growth" paradigm states that "creative destruction" is not only an engine of growth, but is also capable of generating environmentally beneficial change. On the one hand, intra-sectoral technical change can contribute to higher efficiency in the use of natural sources and sinks, e.g. by leading to more efficient combustion engines, pumps, computers or production processes. On the other hand, the concept also stresses the need for an inter-sectoral change – a shift in the importance of different sectors towards those that use cleaner technology and help reduce environmental impacts.

Although this is, at least in theory, clearly a possibility, the case for Green Growth seems – to say the least – overstated. As will be seen in the section on sustainable resource use, there is as of yet no empirical evidence whatsoever that "absolute decoupling" is a plausible scenario for a world economy experiencing continued economic growth. Indeed, there have been forms of "re-coupling" between economy and ecology. One candidate for limiting the positive effects is the so-called rebound effect, which describes the phenomenon that microeconomic efficiency gains can lead to macroeconomic increases in resource use and environmental pressures when the gains are over-compensated for or "eaten up" by the use of financial resources resulting from efficiency.

"Post-growth" and "Degrowth"

This problem has contributed to the rise of lines of thought known as "post-growth" or even "de-growth". Both paradigms stand for a fundamental rethinking of the purpose of economic growth resulting from a deep scepticism towards green growth, often accompanied by doubts regarding the assumed positive social and cultural consequences of economic growth. Post- and degrowth proponents frequently claim that continued economic growth – at least in rich countries – leads to disastrous long-term ecological consequences and also produces detrimental social and cultural effects. Hence, stabilizing or even reducing economic output seems to be the only way to truly sustainable development.

While this kind of thinking has deep historical roots reaching back to economists such as Thomas R. Malthus, John Stuart Mill and John Maynard Keynes, post- and degrowth are still very clearly minority approaches in the (economic) discourse on sustainability. The majority of economists points to the difficulties of managing a

stagnant or shrinking economy and to the global connections between rich and poor countries. It is indeed hard to imagine how, say, a European "post-growth economy" could successfully position itself in a world economy increasingly dominated by high-growth economies in China, India and many South-East Asian countries. On the other hand, the ecological case for letting go of the growth goal is a strong one, for both theoretical and empirical reasons.

Growth as means, not an end

One "solution" to this predicament could be to focus not so much on figures of GDP-expansion or decline, but on the impacts of economic growth. While the goal of increasing GDP remains the hallmark of mainstream economic theory and policy, it should be noted that economic growth can be quite un-economic. As Daly (1991; 1996) noted decades ago, growth is un-economic as soon as its marginal benefits are outgrown by its marginal harm. While it is not trivial to apply a microeconomic idea to the macro level of nations or even the world economy, it is clear that growth, which strongly contributes to climate change and resource depletion and at the same time fails to deliver its social promises, could be defined as un-economic growth.

While this line of thought seems easily applicable to developed countries, many developing countries need (more) growth in order to reach their national goals as well as the SDGs. For many rich countries such as Austria, however, it seems sensible to apply Daly's idea. One result of this application can be viewing growth not so much as an end in itself, but as a means to achieve goals such as a high quality of life. Focusing on the qualitative outcome of economic activities for society and not on the quantitative growth figures could definitely increase the nature of the discourse on growth. In this vein, the initiative "Growth in Transition" does not position itself for or against "Green Growth" or "post-growth", but tries to promote a broad societal debate on the relationship between growth, sustainability, and the quality of life in Austria, Europe, and beyond. "Growth in Transition" is an innovative and internationally renowned initiative that is not only "neutral" in terms of the growth-related frontlines in discourses on sustainability and transformation, but that also brings together a diversity of societal actors relevant to the socio-ecological transformation..

The road to sustainability? Socio-ecological transformation as a challenge to research and policy

"Change by design" vs. "change by disaster" and the "great transformation"

The challenge of global sustainable development is sometimes conceptualized as a choice between "change by design" (or "managed transition") and "change by disaster" (or "forced transition"). The upshot is that change will almost certainly come: either forced change (e.g. climate change with dire ecological, social and economic consequences), or managed change, (e.g. an active climate policy that takes bold measures in order to reduce greenhouse gas emissions and that leads to an economy based on renewable energy). It is obvious that this distinction does not only hold for the issue of climate change, but also for many sustainability topics, be they social, economic or ecological problems.

It is clear that the relationship between economy and environment is crucial for the transformational challenges ahead. Even though the commonly used term (also in this paper) is socio-ecological transformation ("SET"), the economic dimension of it is clear: social as well as ecological issues are intimately linked to economic issues such as growth, efficiency and distribution. As also becomes obvious when one looks at the SDGs, hardly any transformational goals are not in some way linked to economic changes. From combating poverty and providing water and sanitation to protecting the climate, biodiversity and water resources, all these topics are, in one way or another, also economics topics. Since the changes involved in the SET are of dramatic scale, many scientists and activists talk about a great transformation.

"Great Transformation" is a key term in the discourse on sustainability nowadays. It originates from a book published as early as 1944. Karl Polanyi's *Great Transformation* is a classic of economic sociology. In this masterpiece, Polanyi describes the origins of market society or, in other words, the birth of capitalism – indeed a transformation of enormous dimensions. The use of the term in the context of sustainable development is meant to indicate just that: the size and complexity of the change required to reach sustainable development for several billion people.

Transformation is today a keyword within the discourse on sustainability. The German Council for Global Change, in its 2011 report, has explicitly used Polanyi's work for its analysis of global transformational changes. The aforementioned SDGs are "officially" labelled as a global transformation agenda. The United Nation's SDGs are meant to foster global sustainable development.

Development and growth

For some people, it might by a truism – but in the present context a crucial distinction must be reiterated: While growth is a quantitative phenomenon (the increase of units such as GDP or material flows), development is a qualitative thing. While economists from John Stuart Mill and Joseph Schumpeter to current Ecological Economists have emphasized this distinction, it seems somehow to have been "forgotten" within mainstream discourses on growth (and even sustainability). As early as 1848, Mill wrote about the stationary state, i.e. an economy without growth:

> *"It is scarcely necessary to remark that a stationary condition of capital and population implies no stationary state of human improvement. There would be as much scope as ever for all kinds of mental culture, and moral and social progress; as much room for improving the Art of Living, and much more likelihood of its being improved, when minds ceased to be engrossed by the art of getting on. Even the industrial arts might be as earnestly and as successfully cultivated, with this sole difference, that instead of serving no purpose but the increase of wealth, industrial improvements would produce their legitimate effect that of abridging labour."*

Mill is a frequent reference in many contributions to sustainability discourse. However, it is often underestimated that Mill's vision of a "post-growth world" implied significant societal learning and, as it would be called today, transformational processes. Nevertheless, his ideas of stationarity can be an inspirational source for the discussion of what growth means today and how it contributes (or not) to a good life.

Sustainability and quality of life

The ultimate goal of sustainable development is a high quality of life – today and in the future. As indicated above, growth in this context is not an end, but a means, to improving living standards. Economic activities, in this view, should contribute to the quality of life in a society. Again, it is important to get the relations between means and ends right: Analysing the connections between the economy and the environment is about the contribution of economic actions to the improvement of living standards in a way that does not harm the environment, but indeed secures a sustainable resource base and a sustainable use of natural sinks.

Hence, any economic analysis of sustainable development and the SET necessary to achieve this goal must be "socio-ecological economics." This is not a trivial undertaking: Taking this seriously means constantly to consider the systemic nature of the SET and the interlinkages between economic, ecologic and social changes. This approach is the background of the analyses of the economy-environment interactions that are described in the following chapters.

Economy and ecology: Identifying main focus areas

Obviously, understanding the economy-ecology relationship is of utmost importance when the challenges of sustainability, transformation and quality of life are to be well managed. Towards this end, this report contains an elaboration of the state of knowledge, research challenges and possible political implications in six selected fields of key importance for realising a successful transformation:

- **Sustainable natural resource use**
  The sustainable use of natural resources is a precondition for sustainability and human flourishing.
- **Macroeconomics and the environment**
  In order to understand the challenges of a transformation toward sustainability and sustainable resource use, it is vital to have a realistic picture of its macroeconomic implications.
- **Finance and sustainability**
  Finance is a crucial factor for a successful SET. As mentioned in the Paris Agreement, SDGs and other documents, the financial industry must contribute to positive change. Moreover, the risks of so-called stranded assets (fossil fuels that cannot be burned due to climate policy, redundant infrastructures) also must be considered.
- **Sustainable consumption and production**
  On the microeconomic level of actors, the sustainability of consuming and producing goods and service and the transition thereof are important variables in the struggle for sustainability.
- **Sustainable work**
  Work is not only an important – and resource consuming – economic activity to generate income, but also a very important dimension of quality of life.
- **Transformative learning**
  Learning is a central factor influencing the behaviour of individuals. Education for sustainable development is hence a key element of the SET.

These are obviously very short descriptions of the issues involved. Details will follow on the following pages. We are well aware that even though we tackle a wide range of topics, our elaborations are far from covering all relevant topics to be considered in a socio-ecological transformation. We find, however, that in describing the relationship between the economy and environment along the lines of the work of the Institute for Ecological Economics at WU Vienna, the following pages show the complexity of the challenges ahead.

2
SUSTAINABLE NATURAL RESOURCE USE

STEFAN GILJUM AND STEPHAN LUTTER

The fundamental role of natural resources in a socio-ecological transformation

Due to the growth of the world population, continued high levels of consumption in the developed world, and the rapid industrialisation of emerging economies, worldwide demand for natural resources such as raw materials, energy, water and land is steadily increasing. As a consequence, renewable resources and the ecological services they provide, such as clean water or a stable climate, are at great risk of degradation and collapse (UNEP, 2012).

The depletion of these ecological assets is a serious threat, as human society and the economy are embedded within the biosphere and fundamentally depend on functioning ecosystems. Nature provides humans a steady supply of the basic requirements for life, such as food, water, and shelter, as well as the biophysical basis for economic activities.

BOX 1:
SUMMARISING SUSTAINABLE RESOURCE USE

The increase in the world population and economic development results in unprecedented levels of global natural resource use and related impacts. Political strategies aim at increased efficiency levels in order to decouple economic growth from undesirable impacts by means of implementing a "green economy".

The evaluation of progress towards this goal strongly depends on the indicator used. While territorial indicators mirror the pressures and impacts brought about by domestic resource use very well, it is only footprint-type indicators, which account comprehensively for the sum of all pressures put on the environment along the supply chains of goods and services consumed in a country.

While comprehensive analyses make use of both types of indicators, only the achievement of increased efficiency levels is not yet a sign for an absolute decoupling, where resource use and related impacts are decreasing. The so-called rebound effect has to be dealt with by means of, for instance, resource taxes, in order to avoid an increase in demand for more efficient, and consequently cheaper, products.

Human interference with natural systems has reached a magnitude larger than any natural process. This justifies giving the current geological époque the name "Anthropocene" (Zalasiewicz et al., 2010). Further, the scale of our natural resource use and the related negative impacts have become so large that we are approaching – or have already surpassed – some of the "Planetary Boundaries", i.e. the capacities of ecosystems to provide vital services to our society without being irreversibly damaged (Steffen et al., 2015).

While early approaches of resource governance have mostly focused on one single environmental category, such as energy or greenhouse gas emissions, it is now generally agreed that a socio-ecological transformation requires a systemic perspective, taking into account the interrelations between different types of natural resources. This approach is termed the 'nexus perspective' and integrates the dimensions of materials, energy, water, land and food (Bleischwitz et al., 2018). A nexus perspective avoids partial solutions to the natural resource challenges, i.e. solutions that reduce pressures related to one environmental aspect, but at the same time shift pressures to other categories. A well-investigated example is the increasing substitution of fossil fuels with biofuels, which might lower greenhouse gas emissions, but which increases the demand for water and fertile land (Rulli et al., 2016).

An integrated perspective is also applied in the UN Sustainable Development Goals, which define 17 core topics and related targets to achieve sustainable development on the national, regional and global level by the year 2030 (United Nations, 2015). Natural resource use and related impacts play a key role in a large number of SDGs, including SDGs 6 and 14 on water, SDG 7 on energy, SDG 8 on decent work and economic growth, SDG 12 on sustainable consumption and production, SDG 13 on climate change and SDG 15 on biodiversity.

BOX 2:
NATURAL RESOURCE USE IN THE UN SDGS

While natural resources are tackled in a number of SGDs, SDG 8 (Decent work and economic growth) and 12 (Responsible consumption and production) directly target the achievement of a sustainable management of and efficient use of natural resources by 2030. Also, economic development should be decoupled from the use of natural resources. The use of natural resources as well as the related environmental and social impacts should decrease even as the economy grows. To evaluate progress, two types of indicators are used, territorial and footprint-type indicators. However, these indicators focus on raw materials. Water, land, etc. are covered in other SDGs.

Measuring the natural resource use of economic activities relates to identifying the environmental pressures caused by humans to natural systems, while the ultimate goal is to alleviate the environmental impacts related to resource use, such as climate change or biodiversity loss. Technological optimists claim that through the implementation of eco-innovative technologies and products, it will be possible to decrease environmental impacts even in a situation of rising quantities of natural resource use. However, recent research suggests that there is a clear link between

levels of pressures and impacts, i.e. products that have a high impact also tend to require high levels of resource use in production and vice versa (Steinmann et al., 2016). This poses a challenge in decoupling pressures from impacts and supports claims for a "dematerialisation" (Weizsäcker et al., 2009), i.e. a significant absolute reduction of natural resource use, of our economic activities.

Therefore, in order to avoid trespassing the planetary boundaries with possibly irreversible ecological damage and social implications, there is an urgent demand to set ambitious targets for a reduction of natural resource use, in particular in countries with high per-capita consumption levels. To achieve this, adaptations to the policy framework will be required, demanding well-designed packages of policy instruments to address both the production and the consumption area (Hirschnitz-Garbers et al., 2016).

The next sub-chapter investigates the empirical trends of natural resource use on the global and European levels. The third sub-chapter then discusses the policy implications that can be derived from the empirical evidence.

Trends in natural resource use

BOX 3:
TERRITORIAL VERSUS FOOTPRINT PERSPECTIVE

Traditionally, the economic and environmental performance of a country is monitored by means of so-called territorial indicators, which focus on the national level of production and the related resource extraction, greenhouse gas emissions, etc. However, in the era of globalisation, supply chains are increasingly organised on the international level, thus disconnecting the l ocation of production from final consumption (Liu et al., 2013). This implies that traditional production-oriented, national perspectives are no longer sufficient, as important drivers for the local situation are not taken into account (Giljum et al., 2018). Furthermore, territorial indicators do not account for the displacement of the environmental burden through outsourcing of resource- and pollution-intensive production stages via international trade.

Consumption-based – or "footprint" – indicators consider the environmental pressures and impacts embodied in internationally traded products, as they trace back the origins of final products along the supply chains of their components (Wiedmann, 2016). For the design of meaningful policy responses in the context of sustainable production and consumption, both international supply chains and the reduction of global environmental and social impacts of consumption have to be taken into account. Hence, only both types of indicators taken together provide a comprehensive basis.

Since 1970, within 45 years, global raw material extraction increased more than threefold, reaching almost 90 billion tonnes in 2015. This run for raw materials can be divided into two main phases: a period of modest growth between 1970 and around 2002, and a second period from 2003 onwards, where growth in global material extraction increased significantly. Growth rates were unevenly

distributed among the main raw material categories. Particularly the extraction of industrial and construction minerals increased significantly (by more than 350%), indicating the continued importance of this resource category for industrial development, in particular for building up housing, energy and transport infrastructure especially in emerging economies. Global extraction of metal ores increased by 229%. The share of renewable resources in total resource extraction is thus constantly decreasing (from around 33.3% in 1970 to 26.4% in 2015 (Figure 1).

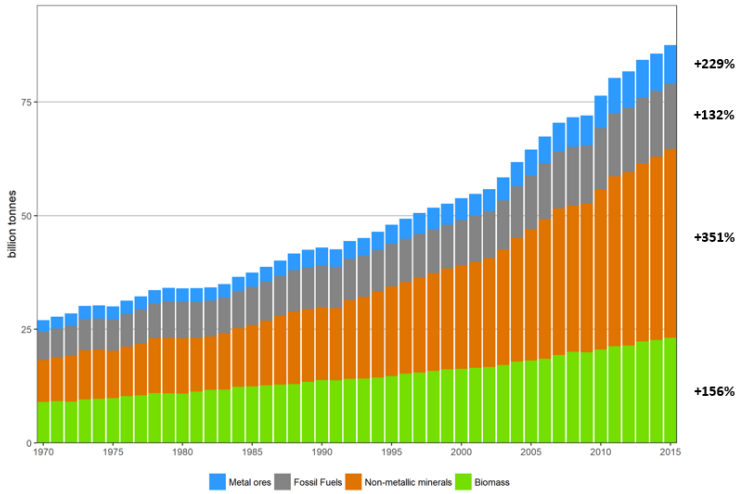

Figure 1:
Global raw material extraction, by material category

When comparing the global development with the EU-28, it can be seen that the European Union's regional material extraction passed its peak in 2007, and since then the extraction of minerals (especially), as well as of fossil fuels, has decreased considerably. Hence, the European Union's contribution to global material extraction is shrinking. While there is still increasing demand for primary as well as processed materials, the raw material basis for their production is increasingly located elsewhere, as will be illustrated below.

The boost in global raw material extraction has been mainly driven by the rise of emerging economies such as China and India, where local raw materials were used to fuel the rise of the national economy and the continuity of the global economy. An analysis of regional trends in material extraction illustrates that Asia's share in global material extraction has increased remarkably. For example, between 1970 and 2015, extraction of minerals in China increased by almost 3,800%, as a consequence of huge increases in demand, in particular for construction purposes. Extraction of metal ores grew by almost 3,900%. Overall raw material extraction in China increased by about 1,350%, as compared to an increase of only 33% in Europe. As a consequence, the shift in global power relations is to a certain extent also reflected in the shares of the world regions in global raw material extraction. While Asia dominates with a share of 59%, Latin America, North America and Europe, with 9-10% each, play only minor roles.

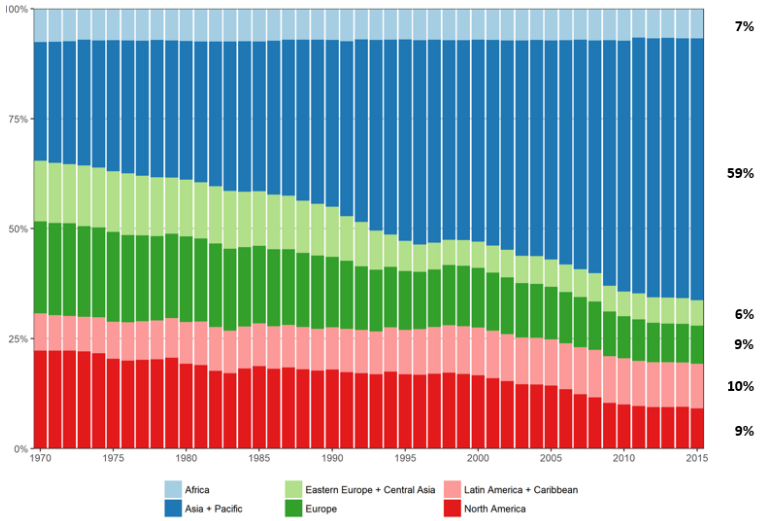

Figure 2:
Regions' shares in global extraction

However, global raw material extraction is not only driven by national demand for industrialisation and production. The current levels of resource use reflect the unprecedented grade of globalisation, and of international trade as its most important component respectively. Resource-rich countries or regions – often located in the Global South – sell their resources to those with scarce availabilities. For many of the extracting countries, the raw material exports are the main source of income, while those with small resource endowments depend on the imports from abroad. As a result, trade in raw materials is increasingly at a higher rate than overall raw material extraction (Figure 3).

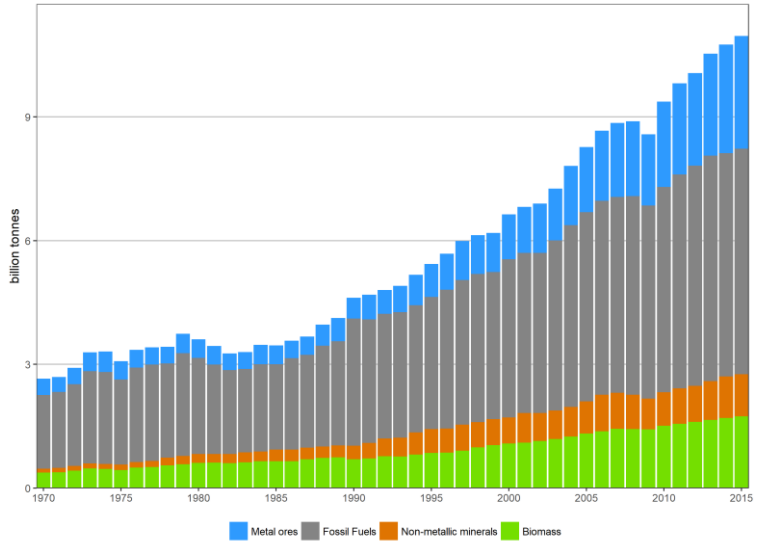

Figure 3:
Global trade in raw materials

However, while exporters have the advantage of revenue when selling raw materials, they have to cope with environmental and social impacts related to resource extraction activities, such as environmental degradation, water scarcity and pollution, child labour, etc. Hence, importing resources from abroad is not only a strategy for dealing with resource scarcity, but also for outsourcing the undesirable consequences. Such strategies are often reflected in the improvement of territorial indicators, e.g. decreased greenhouse gas emissions within the country. Only when comparing the territorial indicators with supply-chain-wide indicators – so-called "footprint indicators" –, can a complete picture be drawn (see box). The latter type of indicators quantifies all the raw materials extracted and environmental impacts caused along inter/national supply chains of final goods and services and allocates them to those countries where they are consumed. Figure 4 illustrates the differences between the territorial and the supply chain-wide perspective for raw material extraction and the material footprint, as well as for domestic greenhouse gas emissions and the carbon footprint. It can be seen that for industrialised countries and regions, footprint-type indicators show considerably higher values. This is due to the fact that regions like the European Union do not have large resource endowments and, as a consequence, import large quantities of natural resources or intermediate products for processing or final consumption. In contrast, many countries with large resource endowments show the opposite trend.

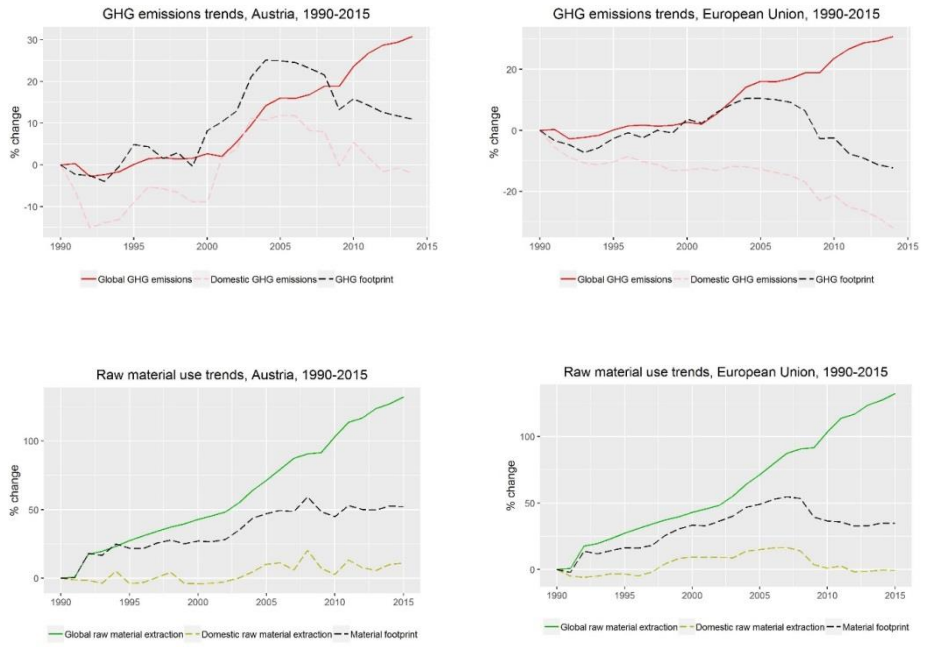

Figure 4:
Comparison of territorial and footprint-type indicators for Austria and the EU-28

When aiming at comprehensive resource management and at designing meaningful policy measures, it is essential to have an understanding of the interrelatedness of a specific country or region with regard to direct and indirect trade in resources and impacts. Global models, which combine information on the structures

of national economies and international trade with environmental data, allow carrying out such types of analyses. Figure 5 shows global interrelations with regard to raw materials, GHG emissions, land and water. While on the left side the geographical origin of these resources can be seen, on the right side their final consumers are identified. In between, the specific trade flows are illustrated. It becomes apparent that Asia is a very important provider of resources of all types, as well as one of the main final consumers. Especially in the case of land, the amounts finally consumed are a lot bigger than the land under current use within the continent. This is a pattern, which in general is typical for Europe. Due to its limited resource endowments, Europe outsources resource extraction (and emissions) to other countries, resulting in higher values for consumption than for extraction. In contrast, Latin America provides its resources to the global market. Especially in the case of raw materials (and here especially with regard to metals), Latin America as a considerably larger share in global extraction than in consumption.

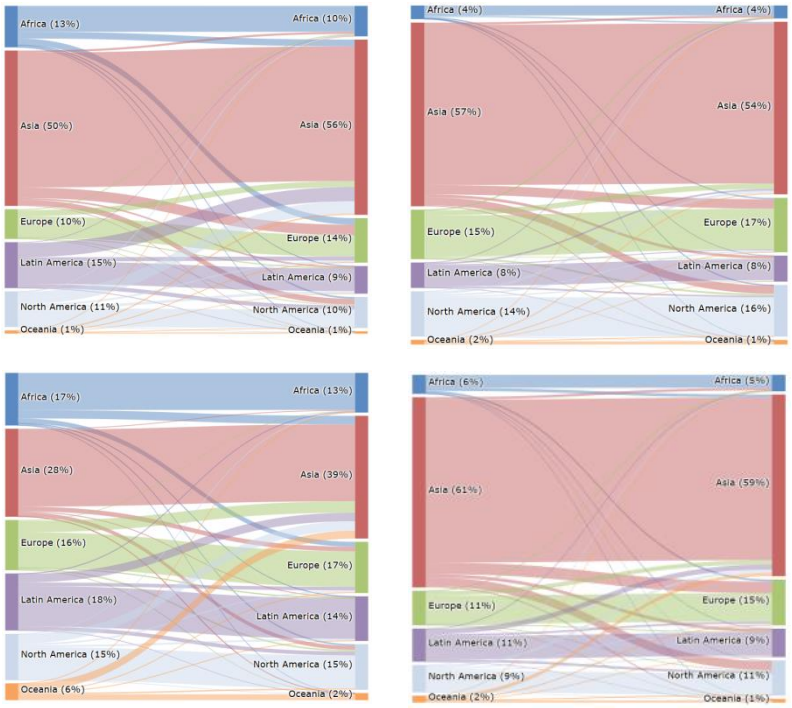

Figure 5:
Flows of raw materials (upper left), CO_2-emissions (upper right), land (lower left) and water (lower right) imbedded in international trade between countries of direct resource use and countries of final consumption

One of the currently most prominent political concepts in the context of sustainable resource management is the concept of “decoupling” (see above). It aims at detaching a positive trend – economic growth, which is commonly regarded as the most important driver for employment and prosperity – from resource use and related environmental impacts. When a country manages to increase its economic performance at a higher rate than its resource use, it is achieving “relative decoupling”. Absolute decoupling refers to cases in which economic growth is accompanied by decreasing resource use. Both cases entail an increase in

productivity in raw material use, but only the latter reduces the pressure on the environment. It is precisely for industrialised countries that absolute decoupling is a necessary goal, to relieve pressure on the environment on one hand and to allow for an increase in resource use by developing countries on the other hand.

Figure 6a provides a comparison between trends in economic (GDP) growth and the material footprint (MF) as well as of the material intensity (MF/GDP) for the global and the European level. Figure 6b shows the same comparison for greenhouse gas emission.

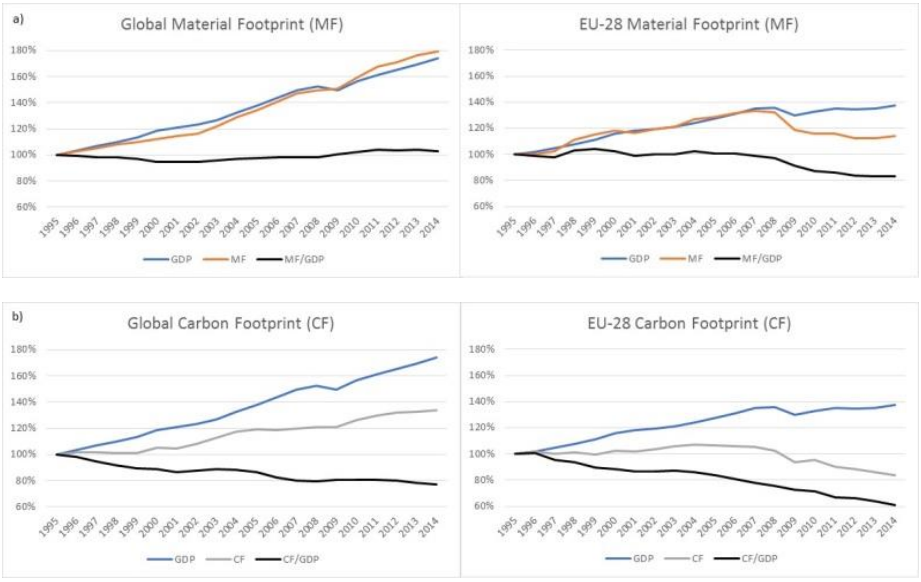

Figure 6:
Global and EU-28 trends (GDP, MF, MF/GDP, CF, CF/GDP)

Figure 6 illustrates that globally we are living in an era where resource use and GHG emissions are steadily increasing. In the case of raw materials, the world is even in a phase of "re-coupling", where relative decoupling trends have stopped and resource use is growing faster than the economy. For both types of resource use, it can be seen that intensity levels have remained stable over the last years. Also in the European case, former decreases in material intensity have ceased and intensity levels become stable, while in the case of the carbon footprint absolute numbers are clearly decreasing. However, the specific countries perform very differently with regard to decoupling successes. The majority of the countries have achieved relative material decoupling during the last years, while only a lower number of countries have reached absolute decoupling, for example Germany or Italy.

In general, the concept of decoupling is increasingly questioned. The main barrier identified is the so-called "rebound effect". Experiences show that efficiency gains through, for instance, technological or management developments normally lead to lower prices of products, which in return results in a higher demand for these products. Hence, without accompanying policy measures, endeavours to increase resource efficiency will always be overcompensated for by increasing demand.

The need for an ambitious European and global policy framework

The empirical trends analysed in the previous chapter clearly illustrate that current trends are unsustainable on the global level and that insufficient progress is being achieved in high-consuming rich countries, such as European countries, to achieve an absolute reduction of natural resource use. There is an urgent need to develop and implement an ambitious policy framework to reverse current trends.

In recent years, detailed calculation methods have been developed in order to identify the hot-spot sectors that contribute most to the resource footprint. For example, a recent study investigated the EU-28 material footprint and found that the top sectors with the highest contribution to the footprint were construction/ housing and biomass-based products, including food and wood/paper products (Giljum et al., 2016). Together with mobility, which has a key role with regard to greenhouse gas emissions, resource policies should focus on these sectors. A further interesting result was that around 25% of the total European Union's material footprint was induced by service sectors, such as health and public administration. Thus, also service sectors, which contribute an increasing share to GDP in countries worldwide, should receive attention when designing resource policies.

However, policy-making in the area of resource use and resource efficiency is complex and challenging, given that resources are used across all sectors of the economy and supply-chains are increasingly organised on the international level, involving a wide range of different actors across national boundaries and on global markets (Ekvall et al., 2016). Furthermore, improvements in resource efficiency might trigger higher demand for certain products through the reduction of production costs and thus cause an unintended increase of demand for resources on the macroeconomic level: a phenomenon called "rebound effect" (see above) (Santarius, 2014). Due to this complexity, a systemic approach is required in policymaking that combines different instruments into a well-designed mix, taking into account the underlying drivers of the related problems and the possible synergies between the instruments (Hirschnitz-Garbers et al., 2016).

In recent years, European resource policy has focused increasingly on the concept of the 'circular economy' (European Commission, 2015) – see also the chapter on sustainable production and consumption. The EU Circular Economy Package involves a wide range of measures and initiatives, including revised legislative proposals on waste management, new topic strategies such as the recently adopted 'EU Strategy for Plastics in the Circular Economy' (European Commission, 2018), as well as the setup of a monitoring framework to evaluate progress towards the realisation of the circular economy.

From a scientific point of view, these initiatives to move the European economy towards a circular economy are welcome. However, some key elements that are required for the transition towards an economy with significantly lower inputs of natural resources are missing. The first issue relates to the setting of policy targets. While the European Union has agreed on targets for various waste streams, such as a target of recycling 65% of municipal waste and 75% of packaging waste by 2030, no targets exist for the overall level of resource use and increases in resource efficiency. However, without quantitative targets for the

absolute levels of resource use, circular economy strategies cannot ensure that the planetary boundaries will not be trespassed, as an economy can be circular at very different levels of per-capita resource use.

The second issue relates to the types of measures envisaged to support the transformation. The EU Commission aims to implement a range of specific measures targeting specific waste streams and supporting the development of circular solutions. However, an overarching strategy to use the price mechanism for triggering a long-term change is not being pursued. For example, in the context of the above-mentioned 'Plastics Strategy', the European Union could have pushed for the implementation of a tax on plastic production or on the non-energy use of oil. These types of instruments, designed to increase prices of natural resource use, should be integrated into a broader re-design of the tax system as part of an environmental tax reform (ETR). Various scientific studies have shown that a well-designed ETR could substantially reduce GHG emissions – and more broadly, natural resource use – while stimulating innovation and investments in sectors of key importance for a socio-ecological transformation, such as renewable energy and sustainable transport (Ekins and Speck, 2011).

If the European Union were to embark on a truly ambitious implementation of the resource efficiency and climate policy agendas, this would have consequences in many other world regions, as Europe is a major importer of natural resources and embodied greenhouse gas emissions (see chapter above). In addition to the domestic perspective, the international dimension therefore needs to be adequately addressed. The enforcement of stronger rules and regulations on social and environmental standards, as well as the establishment of prices that reflect the true social and environmental costs, could possibly lead to a decrease in resource extraction as well as in overall trade volumes. While this could be regarded as a positive aspect from an ecological point of view, the improvement of global social and environmental standards as an important aspect of a socio-ecological transformation must not disadvantage poor developing countries. Industrialised countries will therefore need to provide substantial financial support to co-finance the costs of improving social and environmental conditions, as envisioned, for example, in the Global Marshall Plan (Yunker, 2014).

One key policy area that needs to receive attention is international trade policy. In theory, international trade could contribute to a reduction of resource use if products were produced in those countries that require the smallest amounts of natural resources and if products were exchanged afterwards (Dittrich, 2007). However, due to a large number of factors, including the above-mentioned limitation of current price mechanisms to reflect the true environmental and social costs, this efficient allocation of global production is not achieved at present. In contrast, international trade has been identified as a main driving force for growing natural resource use on the global level (Plank et al., 2018), as well as increasing greenhouse gas emissions (Hoekstra et al., 2016).

A policy environment supporting a socio-ecological transformation, including the internalisation of external environmental costs related to international transport, could therefore lead to a regionalisation of material cycles for some products, such as agricultural products or wood for construction purposes. At the same time, circular economy measures, such as increasing recycling rates for metal

ores, could help in closing the loops for materials that are not available in a country or region and thus decrease the dependency on foreign and potentially instable supplier countries.

This change of regionalisation of the supply chains for some products is also being accelerated by several economic factors (see Backer et al., 2016). First, labour costs are rising significantly faster in emerging economies than in industrialised countries, thus shifting the competitive advantage away from previously low-cost economies. Second, consumer demand is becoming ever more individualised, requiring the capacity of business to react quickly to the increasing demand for customised products. Third, digitalisation and advanced robotics will allow production also in higher (labour) cost environments. These factors will – at least for some products with a high degree of customisation – lead to a more regionalised production structure in the future.

Future research agenda

The availability of data, methods and models required for the investigation of issues related to natural resource use and resource efficiency has greatly improved in the past few years, both on the European and international level. This has fuelled a wide spectrum of research on resource use-related questions, from investigations of resource availability and criticality of supply via assessments of resource flows along global supply chains to questions related to the final consumption of products and services and the related resource footprints.

Despite this rapid development, a number of future research directions can be identified that will further increase the policy usefulness of these types of assessments in the context of a socio-ecological transformation. Below we list a few of the important upcoming research clusters:

- **Investigating the environmental impacts of natural resource use.**
  While environmental pressures, e.g. in the form of material or water flows, have been widely studied, knowledge of the actual impacts is still limited. One approach is to conduct life cycle assessments of certain raw materials, such as metals, in order to estimate the various impacts along the whole production chain (van der Voet et al., 2018). Another direction of research is to move from national assessments to spatially explicit assessment in order to link resource flows to environmental problems on the local and regional level, such as water scarcity, deforestation or biodiversity loss (Lutter et al., 2016; Moran and Kanemoto, 2017). The ERC project "FINEPRINT", currently carried out at the WU's Institute for Ecological Economics, is devoted to assessing the material footprints of consumption and the related environmental and social impacts with high geographical resolution (see www.fineprint.global).

- **Improving data and methods to assess the transition towards a circular economy.**
  Resource use accounting and modelling have so far focused on the input side of the economic system. Advancement of knowledge is required in order to obtain a comprehensive picture of the economy, including the accumulation of resources in stocks within the economy (e.g. buildings, roads, etc.) as well as the generation of waste (Krausmann et al., 2017). Further, secondary use of resources (e.g. recycling, upcycling or down-cycling) needs to be more closely researched in order to design and monitor circular economy policies. There is also a need to better understand how certain physical stocks within society (e.g. the stock of various transport modes) are linked to the provision of services and well-being of people (e.g. transport services).
- **Modelling future scenarios of sustainable resource use.**
  Given the current unsustainable trends on the global level (see above), it is very challenging to achieve a significant absolute reduction of resource use, in particular in countries with high per-capita consumption levels. Although some studies have been performed linking data on natural resource use with economic models to evaluate the impacts of resource policy measures (Giljum et al., 2008; Schandl et al., 2015), there is still a lack of detailed modelling capacities. The integration of detailed environmental data and resource footprint models into state-of-the-art economic modelling approaches, such as Stock-Flow-Consistent Models (see Chapter 2), is one of the potential routes that is currently being explored by the research community.

3
ECOLOGICAL MACROECONOMICS, GROWTH AND THE ENVIRONMENT

ASJAD NAQVI AND NEPOMUK DUNZ

The world is facing a triple crisis: ecological deterioration and climate change, the increasingly unequal distribution of income and wealth in a continuously globalizing world, as well as financial upheavals and recurring economic recessions (Naqvi, 2015; Rezai and Stagl, 2016). Ecological macroeconomics demonstrates how these crises are interconnected and related to each other. As such, it provides a holistic approach that is in tension between these three spheres (the economic, ecological and social spheres). In that vision, the ecological question cannot be analysed without taking the social dimension of policies into consideration. Viewing them in isolation bears the danger of generating feedback effects that might lead to increased inequality or financial upheaval. Hence, ecological macroeconomics' research agenda is concerned with analysing the role of income distribution and finance with respect to climate change and other ecological issues.

The issues of climate change, resource depletion and environmental deterioration first became known to a wider audience with the publication of the "Limits to Growth" report by the Club of Rome in 1972 (Meadows et al., 1972). Since then, academic research, political parties and international institutions have been established that place sustainability challenges at the core of their agenda. Nevertheless, despite many international conferences that attempted to find effective solutions to the ecological challenges, only slight progress has been made and the state of the environment continues to deteriorate at a terrifying pace. In short, the global ecological crisis is far from being resolved and no effective solutions appear on the horizon. Deforestation of rain forests, soil degradation due to heavy use of fertilizers, biodiversity loss, water scarcity and global warming, to name a few, represent great dangers for humanity. Importantly, all these environmental challenges also bear a social and economic dimension. Soil degradation could endanger food security and enhance conflicts about the remaining fertile land. Migration and deteriorating working conditions might be a consequence.

The interlinkages of the different dimensions of these issues demonstrate their inherent complexity and are arguably the reason why effective international treaties are so difficult to reach. Climate change might function as an example of this complexity as it entails: (1) contradicting interests (e.g. countries differently affected by climate change); (2) uneven distribution of power (e.g. small island states vs. industrialized countries); (3) a great level of uncertainty regarding consequences; (4) tipping points and climatic patterns; and (5) the necessity for deep structural changes in the mode of living (e.g. consumption patterns, travel habits).

Hence, from an academic standpoint, the question arises of how to deal with such complexity to provide useful recommendations for policy makers.

BOX 4:
THE SDGS AND ECOLOGICAL MACROECONOMIC MODELLING

The in 2015 adopted Sustainable Development Goals (SDGs) address social, environmental and economic development issues. Nevertheless, some of these goals conflict with each other, requiring policy-makers to assign priorities. For instance, Goal 8, "decent work and economic growth", might be complementary and even crucial for goal 1, "no poverty", but it might have ambiguous effects on inequality, Goal 10, and might conflict with Goal 13, "climate action", since more economic growth still increases greenhouse gas emissions. Ecological macroeconomics highlights that these goals cannot be pursued in isolation, but politicians, business and civil society need to apply a systems perspective to effectively design policies for sustainable development.

sustainabledevelopment.un.org

Ecological macroeconomic models can lay out existing and evolving trade-offs between distinct SDGs by applying a systemic view and thus helping policy-makers to make informed decisions. Scenario analyses with the later presented ABM and SFC models evaluate different social, economic and environmental policy options by explicitly incorporating the diverse feedback effects these policies could induce. Thus, these models can explicitly point out winners and losers of distinct policies, a key advantage of ecological macroeconomics.

A wide range of propositions regarding how to best tackle the current environmental crisis exists within the field of economics. Approaches range from adjustments of market failures based on the implementation of a global cap and trade scheme for carbon emissions to propositions for a degrowth-society including radical changes to the current mode of living. Such radical changes, however, would require abandoning the pathway of mass consumption and cheap fossil fuel based energy. No matter which pathway is proposed, they all have in common that they have wide-ranging economic and societal implications that need to be understood and analysed.

Requirements for macroeconomic modelling

Standard macroeconomic environmental models usually apply a narrow view on climate change and ecological issues by focusing on externalities that distort optimal equilibria. For instance, greenhouse gas emissions are considered a negative externality since the full costs are not borne by the emitter but by society in the form of climate change. In other words, the price for emitting greenhouse gases is too low. Thus, overall, economic well-being is reduced, and society would be better off if the emitter were to pay for the resulting costs of its emissions. Consequently, standard economic climate models usually limit their assessment of environmental policies to different growth trajectories of GDP, where the focus is on getting the prices right to achieve the optimal policy outcomes (Pindyck, 2017).

Ecological economics, on the other hand, emphasizes the role of institutions, power relations and social norms, as well as fundamental uncertainty. As the world is assumed to be finite, justice and distribution of limited resources take a prominent role (Constanza et al., 2015). Ecological economics considers the economy embedded within society, which itself is embedded within the environment. The application of this logic acknowledges complementarities and interdependencies of ecological, economic and social challenges and demonstrates that they cannot be solved in isolation. Such an approach constitutes clear progress in the field of economics and provides an opportunity for dealing with ecological and societal complexity.

Nevertheless, ecological economics currently lacks a coherent framework that could provide concrete macroeconomic policy advice (Rezai and Stagl, 2016). Fortunately, progress is underway regarding the development of an ecological macroeconomics, applying the conceptualisation described above, and the field is rapidly emerging. The ecological economics modelling discourse draws on the Post-Keynesian and classical economics principles of fundamental uncertainty. It highlights the role of inter-institutional interactions, path-dependencies, availability of finances and regulation restrictions, which, if acknowledged, result in different policy outcomes than market-based solutions usually proposed by standard models (Fontana and Sawyer, 2016; Monasterolo and Raberto, 2017; Rezai and Stagl, 2016).

The aim of ecological macroeconomics is the analysis of macroeconomic indicators and the exploration of possibilities for reconciling them within the ecological constraints of a finite planet. As such, ecological macroeconomics provides a macroeconomic perspective that analyses policies and trajectories regarding growth and distribution, financial stability, employment, social well-being and sustainable organization of real production and finance. By analysing the resulting feedback effects that reveal potential winners and losers (e.g. firms, banks, NGOs, citizens, etc.), governmental policies could be better designed.

Several crucial aspects need to be addressed and reconciled within ecological macroeconomics (see Figure 7): First, the environment and the distinct contemporary challenges (e.g. greenhouse gas emissions, resource use) that come along with it need to be acknowledged as a binding constraint restricting infinite economic expansion. Second, inequality and distribution, as important indicators of well-being, should play a prominent role in the evaluation of policies. Third, finance and financial stability, as a means of enabling or constraining socio-eco-

logical transformations, need to complement the economic analysis. Fourth, an international perspective that incorporates trade, migration, global value chains and carbon leakages is essential when analysing policies in a world that becomes increasingly globalised. Fifth, the drivers of technical change and innovation that could play an important complementary role for tackling the global ecological crisis and shaping social structures and network relationships need to be understood. Finally and linked to the other aspects, the growth imperative requires an analysis of the necessities and benefits of, as well as the alternatives to, economic growth for human well-being. Analysing and examining these aspects constitutes the core of the research agenda of ecological macroeconomics.

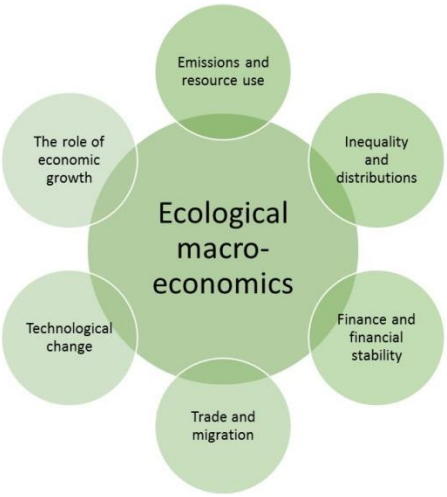

Figure 7:
Important research topics for ecological macroeconomics

We live in a world with manifold shades of grey instead of simplistic black or white dichotomies, which requires multiple and innovative approaches to provide effective and relevant policy advice to solve humankind's huge challenges. More specifically, the use of interdisciplinary and problem-oriented approaches to cope with complex challenges such as climate change, inequality or resource depletion is essential. Since the ecological crisis is highly complex and difficult to approach, there is an urgent need to overcome antagonism between different economic schools and societal actors that hinder cooperation and good solutions. The choice of the modelling approach should thereby not be bound to ideological preferences but rather depend on the adequacy of the modelling approach to best address the research question and to solve the underlying issue.

In that spirit, a new focus is currently being set on the necessities and consequences that a socio-ecological transformation brings. In order to accomplish this, a newer pool of models is being developed to answer various questions, including the role of technical change, North-South interactions, financial frictions and distributional effects. The models are also applied to actual problems, including focusing on financial fragility within the Eurozone and climate risk in Austria.

To present the reader with a sketch of concrete modelling methodologies, the next section introduces two innovative and promising modelling approaches for coping with the challenges explicated above.

Stock-flow consistent and agent-based models

Analytical models based on Post Keynesian theory have existed for many years in the shadow of the mainstream during the great moderation. Since the financial crises, two strands of this literature have gained a special momentum since they are able to endogenously depict complex dynamics relevant for a socio-ecological transformation, such as distribution, political economy aspects to growth, and financial markets: stock-flow consistent (SFC) models and agent-based models (ABM).

Stock-flow consistent (SFC) models (Godley and Lavoie, 2012) explicitly depict stocks of money and several other financial assets and liabilities of multiple sectors in the economy, as well as flows between these sectors, and their dynamic interactions in a consistent accounting structure. Flows can denote "real" transactions, such as consumption, public spending, investment, and financial flows, such as the acquisition of financial assets (bonds, shares, etc.) and the issuance of new liabilities (loans, securities, etc.). Stocks denote the sizes of asset positions on the active and passive sides of the sectors' balance sheets (deposits, capital stock, inventories, etc.). In an SFC model, each flow comes from one sector and goes to another. The corresponding stocks are reduced or increased by the size of the flow. Just as flows lead to a change in stocks, stocks have an influence on flows, for example, via interest or dividend payments.

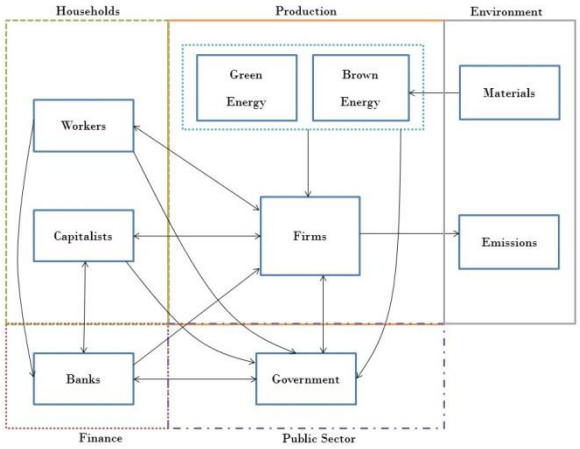

Figure 8:
A stylized ecological SFC model layout (Naqvi 2015), showing the interaction of sectors within the economy (Households, Firms, Banks, and the Government) and with the environment through material flows and emissions

SFC models are an extension of analytical models usually represented by a large set of differential equations in discrete time, meaning they move forward in time step by time step. The models can be solved both analytically, if the parameter space is limited, or numerically, if they are fully calibrated to represent actual economies. They can thus depict truly endogenous dynamics, with a focus on distribution, financial markets, interactions between sectors in a political economy

setting, and the effects of policies on growth dynamics. SFC models are usually represented by categories of the national system of accounts, usually broken down into households, financial and non-financial institutions, government, central banks, and the "rest of the world". Each sector is carefully tracked, usually by central banks, in monetary accounts that provide detailed information on how sectors interact with each other. In SFC models, these transactions are used to estimate parameters for equations pre-dominantly derived from post-Keynesian theory. In this theoretical specification, demand, investment, institutions and path dependency play a crucial role. Such a model can be tested for various policy shocks and how they feed back across the whole economic system, thus demonstrating trade-offs and synergies, a key advantage of SFC models (see Box 4).

Agent based models (ABMs) are a bottom-up methodology where the interaction of individual agents results in meso-macro outcomes that can further feed back on the economy, resulting in endogenous path-dependent outcomes. By reflecting the macro outcomes of the interactions of individual agents, ABMs reflect the famous statement of Aristotle that the whole is more than the sum of its parts. ABMs can be applied as an extension of SFC models, where the stock-flow consistent norms can be imposed on a large set of heterogeneous agents within each sector class.

Both SFC and ABM approaches can be applied to address research questions that arise in the realm of a socio-ecological transformation. The choice of these modelling approaches gives an adequate set of tools to best address the research questions that pertain to the economy-environment nexus, where both the distributions and path-dependencies in outcomes matter.

Practical relevance

Different policy options can be examined within the model framework and the results can be compared. On that basis, an evaluation with respect to a certain policy, say a carbon tax, is possible. As a specific characteristic, the models usually allow an evaluation of these policies based on various ecological, social and economic grounds that go beyond GDP, usually considered as the core indicator representing well-being.

Current relevant research topics include models that address some of the above-identified crucial aspects for ecological macroeconomics: technological change, inequality and distribution, trade and migration, and finance and financial stability. The research described here is relevant for various policy areas ranging from central banking and financial stability boards to ministries of environment and sustainability, trade and economic affairs, labour, innovation, and research and development.

Technical change, distribution, and trade-relations

Technical change is addressed in a recent paper of the institute (Naqvi and Stockhammer, 2018), which incorporates RandD expenditures and resulting endogenous technological change in a multi-sector model and develops a range of different scenarios. The model portrays the interactions of various sectors – households, firms, banks, and the government – and is thereby able to examine

distributive and economic feedback effects that emerge from different environmental policies. Located within the ecological macroeconomic paradigm, the model incorporates labour institutions, which affect wage setting through bargaining processes. The model links RandD efforts to financial limitations of both the public and private sector, which are determined by economic performance. The model incorporates the endogenous technological change framework from the mainstream literature, which highlights that inputs with rising costs will see higher investment to reduce costs, which, if RandD investment budgets are limited, can have different implications for climate policies.

Inequality and distribution are addressed in a recent paper by Rezai et al., (2018), which combines a short-run demand-determined growth model with an output-driven endogenous long-run technical change model to analyse the long-run economic trajectory in response to climate change. The model economy bears the characteristics of being profit-led and profit-squeezing, implying that income distribution and unemployment have direct effects on output and growth. Furthermore, the model incorporates a direct productivity-energy link to account for the fact that, historically, labour productivity growth has been accompanied by the rising productive use of energy (Semieniuk, 2018). Economic growth and technological progress improve the standard of living but also increase energy use. If energy generation is fossil fuel based, this will result in increasing emissions contributing to severe climate change. By endogenising the trajectories of these variables, the model outlines the interdependencies and feedback effects of climate change, capital formation, output, labour productivity growth, unemployment and distribution.

Regarding international trade, a two-regions interconnected balance sheet framework that specifically focuses on North-South interactions can be applied. The model introduces heterogeneous and bounded rational agents that interact in imperfect goods markets. The model consists of fully tractable financial, employment and material flows across multiple agents and sectors of the economy. As such, financial, economic and distributional feedback effects of environmental policies on a North and a South region can be tracked and evaluated. As an extension to the model framework, financial risk and development banks will be added that highlight distinct asset risk classes and the facilitating role of developmental financial intermediaries for enabling sustainable development.

Climate and finance

Putting more emphasis on the financial system within a SFC framework exposes the issue of financial intermediaries' exposure to climate related risk. Finance is crucial for green technical change, since a shift in energy and transport infrastructure requires immense (up-front) investments. The financial resources for financing these investments need to come from somewhere, which, more importantly, implies that they will be missing in other areas, such as social security systems (government) or non-climate related investments (private sector). Furthermore, if financial markets have not fully priced in the risk of climate change, abrupt shocks due to stricter environmental regulation or climate change impacts, such as higher frequency of extreme weather events, could result in massive market upheavals. Such financial market upheavals have tremendous

consequences for the economy and for society, as the financial crisis in 2008 and resulting sovereign debt crisis in 2010 have demonstrated. Hence, it is of great interest for policy-makers to consider the climate risk exposure of financial markets and to understand the implications of portfolio compositions.

Another research project concerned with financial fragility in the Eurozone constructs a novel macroeconomic model, which incorporates the endogenous dynamics of the creation, valuation and distribution of financial assets and their repercussions on the real economy. The model includes complex financial markets and the shadow-banking sector, which enables it to simultaneously address issues concerning economic growth, asset price inflation, pro-cyclical leverage effects, and financial fragility in the Eurozone. These phenomena lead to business cycles induced by financial markets, which are referred to as "Kindleberger cycles" (Kindleberger and Aliber, 2015). The model is calibrated to recent economic developments in the Eurozone, and can be used to assess the sustainability of the current growth path and evaluate policy options to stimulate sustainable growth.

Another type of model is designed for providing forecasts of various indicators. These models are usually large-scale empirically based models. An example of that kind of modelling is the development of a large-scale institutionally detailed empirical stock-flow consistent (SFC) model for the Austrian economy (Miess and Schmelzer, 2016). The model includes multiple sectors as well as financial assets and instruments. All parameters are strictly derived from empirical data, and the model is validated by replicating past dynamics (time series data of all variables for 1997-2016). While constantly expanded and improved, the model aims for medium to long term forecasting of important economic indicators.

Agent-based models and natural disasters

One application of ABMs considers the estimation of indirect economic losses from natural disasters (Naqvi, 2017; Naqvi and Rehm, 2014; Poledna et al., 2018). Reliable estimates of these indirect economic losses are currently out of scientific reach. To address this problem, a novel approach is proposed that combines a probabilistic physical damage catastrophe model with a new generation of macroeconomic agent-based models. The ABM moves beyond the state of the art by exploiting large data sets from detailed national accounts, census data, and business information, etc., to simulate interactions of millions of agents representing each natural person or legal entity of the Austrian national economy. The catastrophe model introduces a copula approach to assess flood losses, considering spatial dependencies of the food hazard. It can be shown that moderate disasters induce comparably small but positive short- to medium-term, and negative long-term, economic impacts. Large-scale events, however, trigger a pronounced negative economic response immediately after the event and in the long term, while exhibiting a temporary short- to medium-term economic boost. Winners and losers can be identified in different economic sectors, including the fiscal consequences for the government. Indirect economic effects of natural disasters are also related to economic resilience, as is demonstrated in Figure 9 below. It shows that after a certain damage size, the potential of an economy to recover from a natural disaster is exhausted and positive growth effects due to reconstruction activities are outweighed by the economic losses inflicted by the

disaster. At this point, the limits of economic resilience mark the threshold where natural disasters become systemic events. Policy applications of the ABM include the assessment of economic resilience to natural disasters and the identification of possible policy actions to prepare for and alleviate the consequences of such events. It is important to identify potential economic losers of these events to optimally prepare for fair and efficient post-crisis management. Due to the fine-grained economic structure of this ABM and its character of a "simulation laboratory" to evaluate the effects of endogenous and exogenous shocks, the model offers a wide range of additional possibilities for policy-relevant applications. The results of the model could thus be interesting to (among others) stakeholders such as policy makers in environmental ministries in Austria and Europe, experts in the field of climate change impacts in Austria, financial regulators at central banks, or finance ministries (budget implications of tax changes).

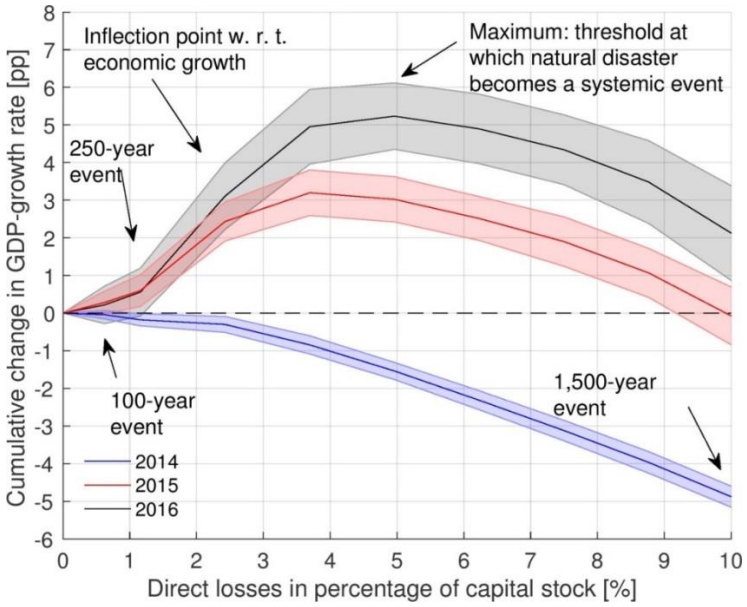

Figure 9:
Cumulative changes in GDP growth relative to the baseline scenario as a function of the direct damage as a percentage of GDP[1]

Conclusions: Policy implications and research needs

The aforementioned work has a strong science-policy interface character, implying that the projects aim to inform and support policy-makers by pointing out synergies, trade-offs and uncertainties that come along with various policies. Several members of our research area also work within policy institutions such as the Austrian WiiW (Vienna Institute for International Economic Studies), IIASA, and

[1] Results are shown for three different years after the disaster: 2014, 2015 and 2016. Shaded areas cover one standard deviation above and below the mean values. One year after the event (2014), all disaster sizes are associated with negative growth relative to the baseline scenario. In contrast, for the years 2015 and 2016 (two and three years after the event) there exist inflection points and maxima for GDP growth, indicating the existence of direct damage sizes that determine a threshold where natural disasters become systemic events.

the IHS or have close contacts to central banks, unions (Chamber of Labour) or ministries, providing strong linkages to the policy area. The aforementioned research strands aim to be *policy-relevant* but not *policy prescriptive*: The aim is to identify issues and respective policy choices, to help in implementing these policy choices, and to monitor as well as evaluate effects of these policy choices to provide policy-makers with options by pointing out their various implications explicitly.

For doing so, a reflexive governance approach is applied that embraces interactions and feedbacks between ecological, social and economic problems that need to be accounted for when analysing drivers of and barriers to a socio-ecological transformation. Such an integrated perspective on contemporary global policy challenges, meaning that issues have interrelated drivers and feedbacks that require an understanding of these interactions, is prevalent in the system dynamics approaches. It further requires an interdisciplinary range of expertise to cope with the variety of feedback effects. Synthesizing different kinds of expertise into the above presented model types can generate relevant and well-informed policy options by varying potential economic or climate outcomes, thereby outlining different scenarios.

For the socio-ecological transformation to become a success, a new paradigm for analysing and coping with the contemporary global policy challenges is required. Social, economic and ecological issues are interrelated and potentially enforce each other. As such, addressing these challenges in isolation is in the best case ineffective and in the worst case even counterproductive. Hence, a macroeconomic perspective that can cope with the inherent complexity and acknowledge feedback effects between these spheres is essential. Ecological macroeconomics allows for this by deeming institutions, path-dependencies, finance, the environment, well-being and their respective interactions important. While a coherent framework is still underway, models already exist that entail these characteristics and that are able to run scenarios for evaluating different sets of environmental, social and industrial policies. We especially view the above-mentioned aspects of environment and resource use, inequality and distribution, finance and financial stability, trade and migration as well as technological change (see Figure 7) as crucial for answering concrete research questions in the realm of a socio-ecological transformation. 'How can we stimulate financial flows towards green projects? What are the social and distributive implications of environmental policies? What role can technological change play in achieving the 2°C target?' are sample questions that our current and future projects aim to address. Research focused on these aspects offers policy-makers concrete options for tackling current contemporary global policy challenges and supports a social-ecological transformation.

Nevertheless, many questions are still unanswered, and a continuously deteriorating environment requires effective and fast policy action, which is currently erratic. In fact, the triple crisis is far from being resolved. In the spirit of Antonio Gramsci, this situation leads one to be pessimistic about the intellect, as current environmental and societal dynamics point towards a challenging and gloomy future. However, we endorse the optimism of the will in conducting research that aims to find pathways for enabling all creatures a prosperous and peaceful future on this planet.

BOX 5:
MACROECONOMIC MODELLING – A SUMMARY

Challenges

Social (e.g. poverty, inequality), economic (e.g. financial crises, recurring recessions) and environmental (e.g. climate change, resource depletion) problems are interrelated, requiring alternative approaches and policies.

Proposed solution

Ecological macroeconomics accounts for the role of inter-institutional interactions, path-dependencies, availability of finances and regulation restrictions, thereby being able to cope with complexities and to propose context dependent solutions. It acknowledges complementarities and interdependencies of ecological, economic and social challenges and demonstrates that they cannot be solved in isolation.

Modelling approaches in that realm incorporate feedback effects and acknowledge distributive as well as institutional structures, thereby pointing out winners and losers of environmental policies.

Research outlook

Contributing to the conceptual development of ecological macroeconomics that entails the above-mentioned characteristics. Applying this systemic lens to aspects of environment and resource use, inequality and distribution, finance and financial stability, trade and migration and technological change (see Figure 8) to answer concrete research questions and cope with today's environmental challenges.

Using the generated insights to provide concrete policy recommendations in order to be policy-relevant without being policy prescriptive.

4
FINANCE AND SUSTAINABILITY

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Introduction

Finance plays a central role in the functioning of modern societies, for better or worse. On the one hand, having access to finance is a prerequisite for companies and governments to be able to invest. This, in turn, supports long-term economic development and prosperity. On the other hand, an excessive dominance of financial markets and financial motives in shaping economic dynamics can make societies and economies more vulnerable to crises and more prone to income and wealth inequality, as the aftermath of the 2008 financial crisis has shown. Finding the right balance in the interaction between the real and financial dimensions of economic systems is essential for guiding societies along the path of sustainable prosperity.

The role of the financial system is also fundamental for the transformation to a low-carbon economy. Given the magnitude of the socio-economic and climate challenges ahead, this has been increasingly acknowledged by academics, policy-makers and financial stakeholders. An explicit reference to the need for financial flows 'consistent with a pathway towards low greenhouse gas emissions and climate-resilient development' has even been introduced in the Paris Agreement (UNFCCC, 2016).

Two main areas should be considered:

- First, moving to a sustainable economic system requires large-scale investments, which need to be financed. At the moment, however, this is not happening to the extent required. Research is needed to identify the obstacles that are currently preventing sustainable investments and hinder the policy enablers required to overcome them.
- Second, a too-late-too-sudden low-carbon transformation might itself create risks for economic and financial stability, for instance in the form of stranded physical and financial assets. Appropriate policies should thus be designed and implemented to mitigate transition risks and ensure a smooth structural change.

This chapter will present the key features of the debate on both of these topics and will elaborate some thoughts on where research and policy-making should head next. It will also identify synergies to exploit and opportunities for collaboration.

Financing the socio-ecological transformation

Despite the recent expansion of low-carbon and ESG (Environmental, Social and Governance) investing (CPI, 2017), it is widely recognized that transforming our economic system in a sustainable manner will require, compared to current levels, a much larger amount of investment in the sectors of energy, transportation, industry, buildings, and others. In particular, sustainable infrastructural investments are needed in order to meet the demand of a growing population (expected to reach 9 billion people by 2050) while limiting the human pressure on global ecosystems and avoiding a socio-technological carbon lock-in (NCE, 2016). The European Commission estimates that reaching the EU climate and energy 2030 targets will need additional investment of € 180 billion per year by 2050 (EU High-Level Expert Group on Sustainable Finance, 2018). According to the International Energy Agency, additional global investments required are in the range of US$1.2 trillion (IEA, 2015). UNCTAD also finds a large gap in the investment needed to achieve the Sustainable Development Goals (SDGs), which will take between US$5 to $7 trillion of investments in transport, power and water infrastructure, agricultural and rural development, climate mitigation and adaptation, health and education (UNCTAD, 2014). The investment gap in developing countries alone is about US$2.5 trillion.

A first way to fill this large investment gap is to employ public finance in the form of government spending, lending from development banks or international development aid. While public finance is likely to play a crucial role in the management of the low-carbon transformation, a number of obstacles are currently preventing it from being scaled up. For instance, many national governments are currently constrained in their public spending either by high costs for accessing finance on international markets (i.e. the case of low-income countries) or by being subjected to tight budget constraints and austerity measures (Gottschalk and Poon, 2018). International aid flows – either in the form of bilateral flows or multilateral 'climate funds' - have never gotten close to providing the required level of finance (OECD, 2017). The action of development banks has been limited by their inability to create credit autonomously and by the conservative management of their leverage ratio (Humphrey, 2015).

Box 6:
WHAT IS SUSTAINABLE FINANCE?

'Sustainable finance' identifies a broad set of financial assets and transactions supporting activities that contribute to the socio-ecological transformation.
A first distinction can be drawn between investments in physical assets and investments in financial assets:

- **Physical investment**
  This can be interpreted as the core of the technological transition. It involves any transaction aimed at purchasing sustainable capital goods. Examples of these transactions include: a utility company purchasing wind turbines from a turbine producer; a household purchasing an electric vehicle; and a government investing in the modernisation of its electricity grid.
- **Financial investment**
  Producers of sustainable physical assets, as any company, usually require external finance in order to be able to invest and produce. Sustainable financial investments include any transaction with which a sustainable business creates and sells a financial asset to finance its activities. Depending on the type of company and the advancement of the technology, external finance can flow from commercial banks, capital markets, private equity investors, development banks, and others.

Sustainable financial investments can be aimed at two main types of businesses:

- **Sustainable businesses**
  Investments in all those companies that actively contribute to the development or rolling out of sustainable technologies (e.g. a producer of solar panels).
- **Responsible businesses**
  Investment in all those companies that, while pertaining to a different productive sector, employ the assets or goods produced by sustainable businesses (e.g. a software company that relies on clean electricity to run its operations). This is often referred to as ESG investing, where ESG stands for Environmental, Social and Governance.

Finally, sustainable financial investments can then take a number of forms, including:

- A bank opening a credit line to a sustainable business;
- An investment fund taking an equity stake in a project (e.g. a solar farm);
- An investor purchasing the listed equity of a sustainable company;
- An investor purchasing 'green bonds' issued by companies, development banks or governments;
- A venture capitalist acquiring a private equity stake in a start-up company.

Therefore, filling the SDG and low-carbon investment gap will necessarily require financial resources from private investors. However, a number of hurdles also exist for private finance in reallocating away from carbon-intensive assets and towards climate-aligned investments.

The main issue is probably linked to the unattractive risk-return profile of many sustainable financial assets and their underlying productive activities. Perceived risks in many low-carbon technologies are still quite high, and sometimes still not quantifiable. Two primary sources of risk exist: first, technical risks linked to technologies that are still relatively new and untested (e.g. renewable energy); second, policy risks arising from the lack of stable, coordinated and coherent fiscal and environmental policies. Policy risks appear to be particularly relevant today, after events such as the retroactive cut of feed-in tariffs in some European countries, the repeal of the Australian carbon tax, or the announced withdrawal of the United States from the Paris Agreement. In order to compensate for these higher-than-average perceived risks, returns on investments should be higher as well. However, generally this does not seem to be the case (Campiglio et al., 2017b). According to a first approximation, returns for investments in sustainable physical or financial assets are roughly in line with their 'non-sustainable' counterparts, although this varies substantially across different technologies and types of assets. ESG-adjusted equity indices, for instance, seem to outperform the general indices, but this does not seem to apply to more focused indices based on environmental technologies[2]. Green bonds are in line with the rest of the market, with even some evidence of a negative green bond premium (Ehlers and Packer, 2017). The volatility of returns is also an issue, especially after the bubble and burst linked to yield-co companies (FS-UNEP and BNEF, 2016).

Another relevant issue has to do with the misalignment between the need for 'patient' (i.e. long-term) finance, willing to accept lower returns in the short-run in exchange for longer-term solidity of investments with positive externalities on the environment and the society, and the short-term orientation of the financial system. The behaviour of financial asset managers is often heavily biased towards the maximization of short-run returns (sometimes on a daily or hourly basis), as these are usually used to evaluate their performance and, ultimately, determine their remuneration (including bonuses) and career advancements (Silver, 2017). From a more macroeconomic perspective, the evidence of the last two decades suggests that financial markets might be prone to amplify economic and financial cycles, with banks injecting large amounts of short-term capital in boom times and withdrawing it in bust times (Borio et al., 2001; Griffith-Jones et al., 2010).

The current macroeconomic context also contributes to making financial investors sceptical of investing in sustainable assets. The 2007-2008 financial crisis, originally bred within the US housing market, had pervasive and long-term macroeconomic effects at the global level (e.g. the 2011 Eurozone crisis). Aggregate demand has been weak ever since, also due to the reluctance of national govern-

[2] See for instance the difference between the MSCI Low Carbon Leaders index, whose main constituents are large multinational companies with high ESG scores (Apple, Microsoft, Amazon, etc.), and the MSCI Global Environment index, which includes only companies with at least 50% of their revenues coming from 'environmentally beneficial products and services'. While the first index outperforms its standard counterpart, the second underperforms it. See https://www.msci.com/esg-indexes.

ments to embark on expensive deficit-augmenting projects, while commercial banks have consistently reduced their lending activity compared to pre-crisis levels, in the attempt to minimise unnecessary risks and reduce their leverage. This has led many central banks to initiate large-scale programs of asset purchase, aimed at providing liquidity to the banking system in exchange for sovereign and corporate bonds[3]. However, it appears this has not been enough to bring economic activity back to its pre-crisis level.

Finally, the new framework of financial regulation introduced with the Basel III Accord (Basel Committee on Banking Supervision, 2017) and aimed at preserving financial stability might be negatively impacting incentives for banks to allocate credit to low-carbon projects and, more generally, to infrastructural projects, which have long maturing time and are considered riskier than traditional, carbon-intensive projects.

In order to tackle these barriers, academics and practitioners are discussing several solutions:

- **Pricing carbon and other environmental 'bads'**
  This is the most frequently advocated policy proposal and is considered as a "first-best" solution. Since environmental resources are often open-access and provided for free, they are usually unaccounted for in the price of goods and services, thus leading to a 'market externality'. Introducing a price to include the use of environmental resources would modify the behaviour of consumers, firms and investors. This concept applies to all environmental taxation, but the current debate has been particularly focusing on the introduction of a price on greenhouse gases (GHG) to mitigate climate change (World Bank and Ecofys, 2018). This can be achieved through the introduction of a tax on the carbon content of goods and service or and through the creation of a market of emission permits, as in the case of the European Trading Scheme. Prices must remain high and possibly increase over time. However, this solution requires: i) introducing a stable, coordinated and credible green policy framework, ii) addressing policy cyclicality, being the climate decision-making process affected by market players' perception of the credibility of the low-carbon transition, and iii) phasing out fossil fuels subsidies, which deliver opposite signals to market actors.
- **Developing new green financial instruments**
  Among the new financial instruments under discussion, "green bonds" have been the most successful. Green bonds are financial assets that are sold to finance a sustainable project. They are considered a "socially responsible promise" because they target investments in climate mitigation and adaptation. The first and still major issuers are development banks, but both municipalities (in particular in China) and governments (Poland, France and Luxembourg in the European Union) have

[3] As a consequence, central bank balance sheets expanded to unprecedented levels. The ECB balance sheet, equal to 12.7% of the Eurozone GDP at the start of 2007, is now around at 41%. The balance sheet of the US Federal Reserve and the Bank of England are both around 22% of their GDP of reference, while the Bank of Japan expanded its balance sheet to up to 96% of Japanese GDP (Data from Wall Street Journal Central Bank Watch)

become strong issuers, followed by corporates. In the last decade, the green bond market has rapidly expanded, reaching US$ 160.8bn in 2017, with subscription systematically overtaking issuance (CBI, 2017). Nevertheless, a main obstacle for a stable development of the green bonds' market is represented by the lack of a harmonized taxonomy of green investments (Ehlers and Packer, 2017)

- **Unlocking the enabling role of development banks**
  Development banks are national or multilateral public financial institutions devoted to supporting the process of national or international economic development. Development banks are often instrumental in funding 'socially useful' activities that commercial banks are unwilling to finance because of excessive risks or low financial returns, or that are willing to finance such activities on more favourable terms only. Many development banks already play a primary role in financing climate and SDG-aligned development. In addition to investing directly in the beneficiary countries, in particular in long-term infrastructural projects, development banks also contribute to the overcoming of market failures by developing and implementing new financial instruments (e.g. green bonds) to deepen financial markets and generate profits for both the public and private investors. For instance, green bonds were launched by the European Investment Bank (EIB) in 2007 and were recently followed by the issuance of the Sustainability Awareness Bond. While EIB has committed to "mainstream climate in everything we do", a network of six major multilateral development banks, including EIB, jointly developed a climate change finance tracking methodology to assess progress on aligning their portfolios toward sustainability (EBRD 2016) (EBRD, 2016).

The financial stability implications of the transformation

Despite being instrumental in providing "a safe and operating space" for humanity by respecting the planetary and social boundaries (EBRD, 2016), a socio-ecological transformation might not come about without costs. Most of the debate in this area has focused on the idea that the transformation might lead a variety of assets becoming 'stranded', i.e. prematurely losing value (Caldecott et al., 2016).

First, a large proportion of reserves of oil, gas, and coal should remain in the ground if the Paris Agreement objectives are to be achieved (McGlade and Ekins 2015). Temperature targets set a global carbon budget, requiring reaching zero net GHG emission before the end of the century (Fay et al., 2015; IPCC 2014). As a consequence of carbon budgets, a large number of already discovered fossil fuel reserves will have to remain in the ground and will become *unburnable* (Carbon Tracker 2013, Pfeiffer et al., 2018). It is estimated that US$ 1300bn has already become stranded in the fossil fuel sector alone, and that US$ 25000bn of fossil fuels' built assets value will become stranded by 2100 (Carbon Tracker, 2013).

Second, a consistent proportion of physical capital and infrastructure is directly or indirectly dependent on the use of fossil fuels and would also be negatively impacted by the transition (Campiglio et al., 2017a). For instance, the generation of electricity, in its turn a fundamental input in the rest of the production process,

is still heavily based on fossil fuels (IEA, 2017). The same applies to the transportation sector, centred on the combustion of oil-derived products in passenger and heavy-duty vehicles, airplanes and ships. These productive sectors, together with others (real estate, chemicals, steel, cement, etc.), could be negatively affected by a low-carbon transition, which might force them to move to different technological foundations and possibly write off a relevant portion of their high-carbon physical capital assets.

Third, the stranding of physical assets is likely to affect the market valuation of their owners and of their financial assets, with potential cascade effects among financial investors exposed to them (Battiston et al., 2017). The direct exposure of individual investors to carbon intensive assets, mostly in the energy sector, that could become "stranded" is relevant and reaches 45% for pension funds and investment funds and 47% for governments. Moreover, exposures of financial investors to each other also matter because they can amplify risk. In particular pension funds hold indirect exposures through their holdings in investment funds (Battiston et al., 2017). Moreover, individual exposures to climate risks due to portfolio allocations on carbon-intense assets and sectors could be amplified by financial interconnectedness, with implications on systemic financial risk (ESRB 2016).

The possibility of climate-related systemic risks to the financial system calls for central banks, financial regulators and other policy-making institutions to look into the issue. In 2015 the governor of the Bank of England, Mark Carney, talked for the first time about the potential negative implications of climate change and the low-carbon transition for financial stability (Carney, 2015). Carney introduced the concept of “tragedy of the horizon” arising from the misalignment between a long-term perspective on climate and the shorter-term view taken by monetary policy, financial regulation and other relevant policies. Several other central bankers have followed suit (Dombret, 2018; Villeroy de Galhau, 2015). Some central banks have also started developing research aimed at identifying and quantifying the relevance of climate-related financial risks (Batten et al., 2016; Regelink et al., 2017).

BOX 7:
THE TRAGEDY OF THE HORIZON BEYOND THE FINANCIAL SECTOR

The issue of the tragedy of the horizon does not apply only to the financial sector, but also expands to non-financial corporations whose management is primarily driven by financial motives. Non-financial firms have prioritized buying financial assets over productive assets and have engaged in massive stock buybacks and in profit distribution through dividends and interest payments to satisfy short-term financial profitability expectations. At the firm level, this corresponds to a shift from the "retain and reinvest" to the "downsize and distribute" model of management and impedes innovation (Lazonick, 2010; Stockhammer, 2010).

The short-term orientation of the "downsize and distribute" type firm management can prove to be a brake on ambitious environmental policies for four reasons:

1. It limits the capacity of the economies to renew their productive structure and to make their production processes more sustainable;
2. It creates an incentive to move the productive activities offshore to countries with less stringent environmental regulations;
3. It creates an incentive for governments to tame their environmental policies to safeguard their fiscal base in the financialisation context;
4. In depressing economic activity, it may weaken the Kaldor-Verdoorn relationship that links demand to productivity: demand steers investment and innovation, which stimulates technical progress and allows for economies of scale, thus enabling higher efficiency in resource use.

In 2016, the Financial Stability Board (FSB) established a Task Force for Climate-related Financial Disclosures (TCFD). Its final report recommended the introduction of metrics and methods (e.g. a climate stress-test) to better inform their investors, lenders and insurance underwriters, and made sector-specific recommendations to encourage companies to voluntarily disclose climate-related financial risks (TCFD, 2017).

In 2017, the European Commission launched the High-Level Experts Group on Sustainable Finance (HLEG) with the aim of providing recommendations to align the European financial system with sustainability. In its final report, the HLEG focused on several issues, including the role of climate risk metrics for portfolios' disclosure, the introduction of a harmonized taxonomy for green bonds, and the possible introduction of green macro-prudential regulations in relation to banks' capital requirements (EU High-Level Expert Group on Sustainable Finance, 2018).

More recently, a group of eight central banks and financial regulators have formed a 'Network for Greening the Financial System'. The network intends to enhance the role of the financial system in managing climate-related risks and mobilising capital for low-carbon investments. In the first 2018 meeting of the network, the head of the French Central Bank, Mr. Villeroy de Galhau, said that central banks need a "forward-looking stress test assessing the comprehensive interaction between climate change and assets and liabilities", while Mark Carney announced that the BoE is considering the introduction of a carbon stress test by next year (NGFS, 2018). The President of the European Central Bank (ECB), Mario Draghi, has

explicitly stated that 'the ECB is a party to the Paris Agreement' and that climate-induced natural disasters 'could pose considerable risk to financial stability' (Draghi, 2018).

Future paths of research / research needs

We believe the most crucial research step to make in the near future is to develop an integrated assessment framework capable of providing a reliable quantitative assessment of the macro-financial implications of climate change and the low-carbon transition. These broad research avenues can be broken down into three interrelated areas of work:

1. Empirical research aimed at identifying and quantifying the exposure of financial investors to climate-related financial risks;
2. Macroeconomic modelling research aimed at understanding the wider implications of climate- or transition-induced financial instability on growth, investments, employment, capacity utilization, distribution and other relevant socio-economic variables;
3. Policy analysis aimed at identifying the most effective combination of policies to achieve a rapid and smooth transition to a low-carbon society, with a particular focus on the role of central banks and financial regulators.

Assessment of climate-related macro-financial risks

The aim of this line of research is to assess the exposure of climate-related financial risks, linked either to physical climate-induced damages or to the low-carbon transition. This can be done:

- At the level of individual financial institutions (financial investors, development banks, central banks);
- At the level of the financial system as a whole.

At the level of individual financial institutions, it has been highlighted that information gaps on portfolios' current exposure to carbon-intense assets and companies, as well as the lack of transparent metrics for climate-related financial disclosure, prevent investors from considering climate in their portfolios' management strategies and credit risk assessment. They also prevent policy-makers from introducing effective policies to smooth the low-carbon transition and prevent central banks and regulators from assessing the sources of risk for financial stability that inform their micro and macro-prudential regulations.

Monasterolo et al., (2018) develop the first carbon risk assessment for development banks applied to the overseas energy loans portfolios of Chinese policy banks[4] and found that negative shocks are mostly concentrated on coal and oil projects and vary across regions and climate policy scenarios, between 4.2% and 22% of total loans value. Given the current leverage of Chinese policy banks, these losses are not negligible in comparison to banks' capital.

[4] Banks responsible for financing economic and trade development and state-invested projects

For two main reasons, central banks are concerned too. First, some central banks manage portfolios on behalf of other public institutions, with the most relevant example being the Norges Bank managing the vast portfolio of the Norwegian Government Pension Fund. Second, central banks hold financial assets as part of their monetary policy operations. These portfolios are unprecedentedly large because of quantitative easing schemes. Research by Matikainen et al., (2017) showed how the corporate bond purchase programs of both the ECB and the Bank of England have been skewed towards carbon-intensive sectors.

Financial regulators are also interested in understanding the *systemic* risks arising from climate change or the transition. Stolbova et al., (2018) develop a network-based climate stress test of investors' portfolios to assess their exposure to climate risks and the impact of climate action (i.e. mitigation and adaptation). Monasterolo et al., (2017) developed two complementary indicators to identify which actor is "vulnerable yet relevant" in the climate finance arena, assessing the GHG emissions intensity of investors' portfolios and their market share weighted for the emissions. Using equity-holdings and loans data for the eurozone, they show that all financial actors are exposed to the manufacturing and electricity sectors, which are the most relevant in terms of GHG emissions.

Another line of research looks at the sectoral consequences of asset stranding within national economies, in particular France and Sweden. Moving to a low-carbon economic system will entail a process of creative destruction that will revamp the productive structure of the economies. Preliminary results for France show that the extractive sector is at the bottom of an 'inverted pyramid' of inter-connections. As a consequence, the low-carbon transition is likely to steer down the value of the financial assets issued by these carbon-intensive sectors – equities, bonds, loans. This, in turn, would affect the balance sheets of the financial institutions holding these financial assets, as evidenced by the works on climate stress tests mentioned above. A spillover of asset stranding could ensue through the interconnections between balance sheets. Moreover, the physical assets of all the downstream sectors relying on carbon-intensive products could become stranded. This could spread along the whole value chain of the economy, incurring major financial and macroeconomic repercussions (Campiglio et al., 2017a).

Macroeconomic modelling

While the empirical assessment of exposure to climate-related risks is fundamental, it does not tell us much about the wider socio-economic implications of climate change and the transition. Wider integrated modelling frameworks are required to develop a comprehensive view (see also Chapter 2 on macroeconomic analysis).

Growing research has been devoted to developing modelling approaches based on Stock-Flow Consistent (SFC), Agent-Based and network models, which are mentioned in the chapter on macroeconomics. Ongoing research aims to investigate and model the low-carbon transition / short-term bias nexus to assess the financial instability that may arise from this "tragedy of the horizon" if firms' management is not driven by long-term goals but by i.e. short-sighted financial

imperatives. By the use of stock-flow consistent macroeconomic models, it is possible to represent the dynamics arising from errors in expectations regarding the following: (1) the required amount of high-carbon capital to satisfy future demand due to a short term bias, and hence (2) possible mistakes in investment decisions and their repercussions in terms of stranded assets, when the climate situation prevents firms from continuing to use high-carbon capital.

Policy analysis

Using insights from the empirical and modelling work discussed above, the objective is to identify the most effective combination of policies to achieve a rapid and smooth socio-ecological transformation.

Campiglio et al., (2018) discuss several measures that are being implemented or are proposed for central banks and financial regulators to intervene in climate-related matters. First, central banks and financial regulators can contribute to the development of methods to assess climate-related financial risks. Second, in line with the work by the TCFD, they can incentivize companies and investors to disclose their exposure to climate-related risks. Third, financial regulators can align regulation to include climate-related risk factors. Fourth, quantitative easing could be used to purchase more low-carbon assets ('green QE' – 'green quantitative easing'). Finally, central banks can put stronger policies in place in order to steer credit allocation, such as credit quotas and specific refinancing lines. These policies are already put in place by the Reserve Bank of India, the Bangladesh Bank, and other central banks of emerging economies.

While quickly expanding, the discussion of the implications of these policies still lacks solid quantitative analyses. Monasterolo and colleagues (2018) developed the first SFC behavioural model to assess to what extent and under which conditions unconventional monetary policies, e.g. a green QE, and new green financial instruments, e.g. green sovereign bonds, could contribute to the scaling up of new investments in the low-carbon transition by influencing investors' expectations. They find that a green QE implemented by targeting green sovereign bonds conditioned to green capital investments (e.g. solar panels) could contribute to putting the economy on a low-carbon energy path, inducing a green multiplier effect that allows for the sustainability of public debt in the long term. Further, they highlight that a precondition for green monetary policies and green bonds to work is the introduction of a harmonized green assets' taxonomy. In another piece of research, Dafermos et al. (2017) explored the climate change – financial stability – monetary policy nexus in a stock flow consistent model. They find that climate change is likely to have a negative impact on firms' capital and profitability, thus causing their liquidity to deteriorate. This, in turn, exerts negative outcomes onto both the financial and the non-financial sectors. Their model shows that a Green QE program is likely to counteract the negative impacts of climate change in limiting the latter while reducing financial instability.

5
SUSTAINABLE CONSUMPTION AND PRODUCTION

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Why sustainable consumption and production?

The central question of "Sustainable Consumption and Production" (SCP) research is "How do humans thrive and, at the same time, use less, waste less, and pollute less?" A socio-ecological transformation of the provisioning systems of goods and services that support human flourishing is necessary in order to avoid the negative effects of current consumption levels and production methods. The increasing pressures on natural resources worldwide caused by current human activity leading to global climate change, biodiversity loss, polluted ecosystems, and the like (as described in Chapter 1) and the macro- and microeconomic challenges related to environmental damages (discussed in Chapter 2) originate from the individual and collective practices of consumption and production. Therefore, SCP is the lynchpin challenge for achieving a socio-ecological transformation towards sustainability, both in developed and developing regions.

BOX 8:
UN SUSTAINABLE DEVELOPMENT GOAL 12 – ENSURE SUSTAINABLE CONSUMPTION AND PRODUCTION PATTERNS

The United Nations 2030 Agenda on SDG 12 states, "We commit to making fundamental changes in the way that our societies produce and consume goods and services. Governments, international organizations, the business sector and other non-state actors and individuals must contribute to changing unsustainable consumption and production patterns, including through the mobilization, from all sources, of financial and technical assistance to strengthen developing countries' scientific, technological and innovative capacities to move towards more sustainable patterns of consumption and production." Source: (United Nations, 2015)

The term "Sustainable Consumption and Production" (SCP) presents an umbrella concept for a diverse and multiple set of approaches. In 1994, the United National Environment Programme (UNEP, now "UN Environment") first defined sustainable consumption and production as "the use of services and related products, which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as emissions of waste and

pollutants over the life cycle of the service or product so as not to jeopardize the needs of future generations" (Norwegian Ministry of the Environment, 1994).

Since then, SCP has become an international priority and is now listed as the twelfth of the seventeen United Nations' Sustainable Development Goals (SDGs), "Ensure Sustainable Consumption and Production Patterns". To achieve this goal, the SCP research field analyses influencing factors and driving forces of patterns and practices of (un)sustainable consumption and production; measures and evaluates their impacts; and proposes and tests intervention and policy measures.

As posited further on, and emphasized by the United Nations itself (Hoballah, 2014), SCP is an inherently complex and systemic field, which rests within the very core of the global economy. As such, its relevance extends beyond its "exclusively" dedicated SDG 12. Taking into consideration the widespread impacts our consumption and production processes have on e.g. various resources (e.g. deforestation, water scarcity) and ecosystems, SCP testifies to the necessary synergies between SDG 12 and other SDGs on the agenda that focus on food issues, water or energy-relevant policies and practices, or, on a more general level, climate change mitigation (Hoballah, 2014). Moreover, as highlighted further on in this chapter, with the cultural embedding of SCP, the area extends also to the urban-focused SDG 11 ("Make Cities and Human Settlements Inclusive, Safe, Resilient and Sustainable").

The appeal and importance of SCP research lie in its approach of jointly considering production and consumption activities. For a long time, the approaches taken to mitigate climate change and reduce resource impacts have focused on improving the efficiency of production processes and developing "greener products" through ecological modernisation and technological innovation. However, while considerable efficiency improvements have been achieved over the last decades, final consumption has been increasing alongside a growing population and higher levels of affluence such that these efficiency improvements have actually been outweighed by mounting total consumption (Wenzlik et al., 2015). While questions about consumption were long relegated to the margins of the debate, over the past 20 years scholarly and policy interest in consumption has grown, turning the field into one of the most vivid among the many strands of sustainability science (Reisch et al., 2016; Reisch and Thøgersen, 2015; Yue et al., 2017). SCP-research avoids an overly one-sided view on prevailing efficiency improvements on the production side and widens the scope for taking action on consumption. Thus, it has increasingly become apparent that both domains (production and consumption) inevitably need to change more or less simultaneously to effect real gains in environmental sustainability and foster a socio-ecological transformation towards human flourishing within environmental limits.

This chapter presents the state of the art of SCP research and introduces the reader to a selection of consumer/producer driven practices that are transforming goods and services, as well as social arrangements. The authors do not claim that this chapter is comprehensive in respect to SCP, as it is impossible to include the many strands of SCP research, but it aims to be informative, surprising and thought provoking for the reader. Some researchers within the field focus on building the theoretical knowledge base within the SCP field (i.e. creating and extending new conceptual frameworks such as degrowth, planetary boundaries,

decoupling growth from consumption, bioeconomy, or circular economy). Some researchers investigate new forms of individual and community consumer practices and lifestyles that redefine *who* and *what* is a consumer (i.e. urban agricultural systems, sharing platforms, prosumers, etc.). Others try to explain the effect of available and emerging technologies on individual and community consumer practices (e.g. digitalization, automation) and production processes (i.e. replacing fossil fuels with alternatives). All SCP research ultimately links to policy and regulations that inhibit, enable, and encourage SCP.

The following sections are structured according to the interlinked concepts of "knowing", or contributions to the knowledge base of SCP, and "doing", i.e. contributions that analyse practice. However, this structure does not belie the assertion that in this field "understandings supposedly informing practice are typically at least as much formed by it. In other words, knowing and doing are not so much distinct as inseparable – especially when it comes to transformation" (Stirling 2015: 67). The rest of the document proceeds as follows. Section 2 discusses "Knowing: Conceptualizations of Sustainable Consumption and Production" and starts by explaining how SCP relates to the bioeconomy and the circular economy. It also discusses the roles of consumers, technology and culture in SCP. Section 3 presents "Doing: Analysing Strategies for Achieving Sustainable Consumption and Production". Starting with the role of the consumer, we outline consumer strategies for mitigating climate change, with a particular focus on food-related practices. Next, we bring up digital sharing platforms to provide an example of the technology-SCP link, and, finally, in order to consider the culture-embedding of SCP, we close with a look into circular business models for adaptive reuse of cultural heritage sites. Section 4 concludes and provides a forward-looking research agenda.

Knowing: Conceptualizations of SCP

SCP asks for a reflective, responsible society supported by knowledge and capabilities to reduce the environmental impacts related to societal goals. To support society in this transformation process, inter- and transdisciplinary approaches of "thinking/knowing" are needed to advance a systemic understanding of SCP from an ecological economics perspective. The frameworks discussed in this section are crosscutting analytical lenses, not limited to a particular industry or SCP activity. The section starts with the recently proposed EU bioeconomy transition as a potential strategy towards SCP biobased carbon pathways. Next, it moves on to explore SCP in relation to the circular economy. The final three subsections look into the role of consumers in SCP, technology, and culture.

SCP in the bioeconomy

A bioeconomy transition takes a crosscutting perspective on SCP because it embeds economic activity, both production and consumption, in the wider risk and resilience dynamics of the interrelated social-ecological system (de Schutter et al., forthcoming-b; Fischer et al., 2015). Bioeconomy is a multi-dimensional, yet

holistic, concept entailing (i) fundamental services in society, in particular food, clothes, construction materials and energy (social dimension), (ii) functioning ecosystems in a limited biophysical environment (environmental dimension), as well as (iii) knowledge based technologies to mitigate climate change while supporting economic development (economic dimension). The broad idea of a bioeconomy transition is based on the replacement of fossil resources, both energy and materials, in the economy with renewable and, hence, low (net) carbon resources based on photosynthesis. However, diversifying a bioeconomy from food to non-food products and services is not without risks, as the biophysical environment is limited and vulnerable to overuse and pollution (Schramski et al., 2015; Steffen et al., 2015). Hence, as the large majority of resource use in the bioeconomy is appropriated by food provisioning systems, exploiting ecosystems for materials and energy services by developed regions – as a production strategy to reduce carbon emissions - cannot evolve independently of (more) sustainable consumption patterns in the economy (de Schutter et al., forthcoming-a).

SCP is a frame condition for a bioeconomy transition in society. It requires a systemic understanding of complex relations between human wellbeing, the economy and the biophysical system, including the climate system. Figure 10 gives a systems perspective on a bioeconomy transition in the social-ecological system: starting with (I) biomass extraction from ecosystems to replace fossil resources, (II) providing for inputs to the macro-economy, and (III) consumed as final products to fulfil basic needs (and wants) in society. A bioeconomy transition exerts (IV) pressures in the direct environment, in particular N and P emissions, biodiversity losses and GHG emissions, resulting in (V) global climate change and ecosystem degradation with emergent feedback effects (risks) on life supporting ecosystem services to society. Figure 10 is a transdisciplinary framework, where (VI) actors become aware and capable of evaluating systemic drivers, pressures and feedback risks related to production and consumption patterns in the (bio)economy (Kammerlander et al., forthcoming).

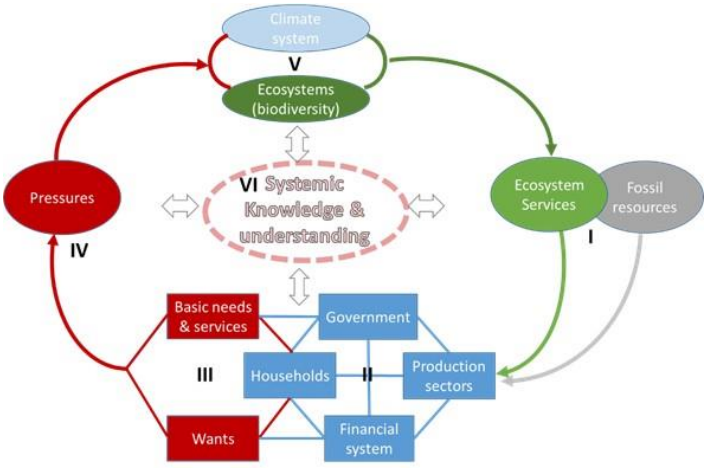

Figure 10:
A transdisciplinary framework to assess and evaluate a bioeconomy transition as a participative process towards SCP in the interrelated socio-ecological system; based on: de Schutter et al., (Forthcoming)

In a bioeconomy transition, functioning ecosystems and, hence, governance of interdependencies in the social-ecological system, become an increasingly important constituent of human wellbeing (fulfilment of human needs). The literature shows that human needs concern the care and protection for the self, the other and the environment (Max-Neef, 1992), thereby providing a new social-ecological perspective on bioeconomy strategies. However, it is not at all clear what a needs-based bioeconomy in a high-income country entails. In relation to SCP, analysis of applied strategies in the local context of high-income countries (Austria) reveals a significant variance in 'social-ecological efficiency', i.e. the amount of resources and/or environmental impact related to the fulfilment of human needs (Kammerlander et al., forthcoming). Is it a societal necessity to replace fossil-based plastics by bio-based plastics in order to mitigate climate change? Is bioenergy a sustainable alternative to fossil fuels in road and air transport? Are rural areas appropriate suppliers of biomass to fulfil basic needs in urban centres, or should bioeconomy strategies be developed in the ecological context of rural areas? These and other questions point to the difficulty, i.e. the normativity, of defining whether certain strategies contribute to SCP and overall human flourishing. Systemic monitoring and participative approaches to advance awareness, knowledge and understanding of SCP and its multiple impacts and trade-offs are important steps towards creating sustainable bioeconomy pathways (International Advisory Council of GBS, 2018).

SCP in the Circular Economy

A compelling area of development in current SCP research is the circular economy concept. The circular economy is a crosscutting theme that is presented as an opportunity to create more competitive, sustainable, and liveable economies. A circular economy strategy stands in opposition to a linear economy strategy, which is the business-as-usual approach summarised in the following steps:

- Extract materials from the environment;
- manufacture materials into products;
- products reach consumers through distributors and retailers;
- consumers use products and discard them as waste and pollution.

Instead, a circular economy seeks to minimize the amount of extraction of materials from the environment and to extend the lifecycle of these materials, as well as to produce less waste and pollution. The adoption of the concept of a circular economy in Europe as an umbrella SCP strategy is moving forward quickly, and many SCP research strands are now connected to the circular economy. The Ellen MacArthur Foundation has been a forerunner in research and advocates for the circular economy concept (see Figure 11): "[A] circular economy holds the promise of prosperity that is restorative and regenerative by design. It is an approach to economic development designed to benefit businesses, society, and the environment. In contrast to the current linear model, the circular economy aims to decouple growth from finite resource consumption." (EMF, 2017)

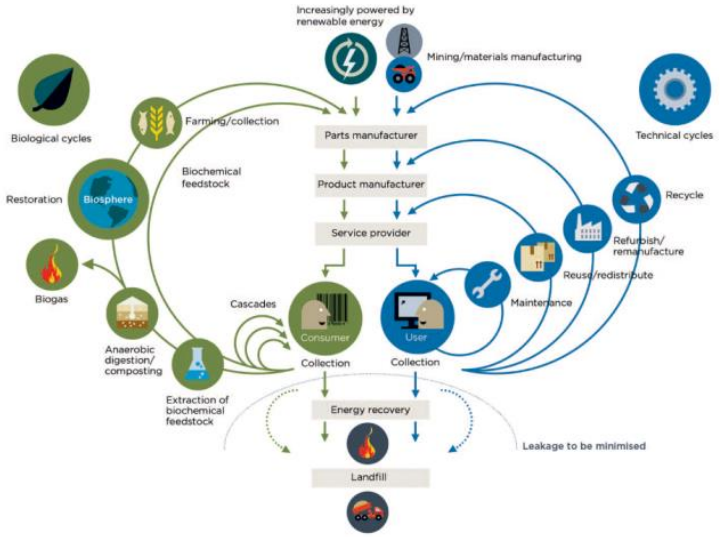

Figure 11:
Circular Economy System Diagram from Ellen MacArthur Foundation (MacArthur, 2013)

China has used the circular economy as an official development strategy for over a decade (Government of China, 2008). Recently, the concept has attracted rising interest also in European political, academic, and public debates. It was adopted by the European Union in 2015 (European Commission, 2015) and the circular economy scope continues to expand, for example with the 2018 "European Strategy for Plastics in a Circular Economy" (European Commission, 2018). Circular economy strategies are also being developed and adopted by cities, e.g. Amsterdam's circular economy strategy and Glasgow's zero waste Scotland strategy (Circle Economy et al., 2015; Glasgow Chamber of Commerce et al., 2016), and nations, e.g. Finland (Sitra, 2016) and Italy (Ministero dell'Ambiente and Ministero dello Sviluppo Economico, 2017) .

Research on the circular economy seeks to better understand consumer-citizens and how environmental contributions of circularity are measured, as well as to develop new business models that aim at decoupling growth from consumption.

The role of the consumer in SCP

Different disciplinary perspectives offer alternative conceptualizations of the agency, or ability to act, of individual consumers and thus their responsibility and contribution in a socio-ecological transformation (Schanes et al., 2016a). For instance, the conventional microeconomic view regards individuals as utility-maximisers who, through cost-benefit calculation, follow the course of action that brings them the most utility. In addition, behavioural economics conceptualises individuals to employ a variety of heuristics to simplify complex decision-making and proposes "nudging" people into voluntarily behaving more sustainably by adjusting the given choice architecture (Thaler and Sunstein, 2009).

Other intellectual perspectives have pointed to the limited potential of individualistic accounts and advocate "going beyond the ABC" (i.e. attitudes, behaviour and choice). They suggest transition management or practice theory as alternative

frameworks for analysing processes of societal transformation (Shove, 2010). The social practice perspective in particular has been applied to various consumption and production contexts, such as urban agriculture (Dobernig et al., 2016), stand-by consumption (Gram-Hanssen, 2010), food waste (Evans, 2011), and energy impacts of ICT (Røpke et al., 2010). Others point to the need for fundamental changes in the deeper structures of society, a turning away from economic growth and over-consumption, and the establishment of alternative systems of production and consumption.

SCP-research and policy require a synthesis and integration of economic, psychological and sociological accounts. While sustainable consumption scholars commonly agree that individual consumption patterns are embedded in social, cultural and material contexts, studies still widely employ the simple frame of the individual (Maniates, 2014). What is needed is an integrated, systemic perspective, which pays sufficient attention to the power exhibited by governments, corporations and socio-cultural institutions and norms (Spash and Dobernig, 2017). In addition, such a perspective should span ecological, ethical and social aspects of consumption.

The role of technology in SCP

Comprehensive conceptualizations of sustainable consumption and production also include looking into the role of technology in fostering change within the practices in question. This has been explored, for example, within sustainability transition theories, which focus largely on socio-technical regimes and infra-structures of provision and supply (Geels, 2012; Loorbach, 2010). Though highly valuable and relevant, the "fruit" of sustainability transition theories research has been criticized for its "technological-fix" orientation, i.e. for seeing technological innovation as inherently progressive (Stirling, 2014). Such a view expands beyond the engaged academic communities to characterize broader social views, political deliberations from the right to the left, and policy-making. The vibrant discussions of the concept of climate geoengineering is a case in point (Cairns and Stirling, 2014), where often uncritical trust is put in various technologies designed to manage solar radiation and remove carbon dioxide. The runaway developments in information and communication technology (ICT) also exemplify these dynamics: ICT is praised for the innovative way it influences not only how we communicate, but also how we consume and produce. However, ICT is rarely called into account for its less beneficial aspects, e.g. its tremendous data-specific energy demands, where "the total carbon footprint of the world's data centres has already sur-passed that of the airline industry" (Bratton, 2016), and which are expected to grow threefold by 2020.

Against such a background, it is crucial to emphasise that modern technological infrastructure does provide resources that could form the basis for a drastically different socio-economic and political system (Srnicek and Williams, 2015; Stirling, 2015), consequently altering our consumption and production practices. It is paramount to the research on SCP to care whether (and how, and where) this technological infrastructure can enables the persistence of the currently dominant economic growth-driven interest.

The role of culture in SCP

There are two facets of culture's role in SCP. First, culture, broadly defined, is the collection of beliefs and customs that influence the decision-making of human groups. Therefore, social arrangements and transportation arrangements, for example, as well as consumption arrangements at the micro and macro levels, are influenced by the culture of a community. From this perspective, comprehending the impact of culture is essential for developing and analysing effective SCP initiatives. This is a widely accepted socio-economic perspective, incorporated in Practice Theory and Consumer Culture Theory. An example related to the bio-economy strategy discussed above is reducing meat consumption, which is a food choice that is bound to cultural perceptions and cultural change (Asp, 1999). The second facet of culture and SCP is the controversial topic of the role that culture should play in transformation towards sustainability. For example, the 2015 report "Cultural Heritage Counts for Europe" adopted the "four-pillar approach to sustain-ability" whereby culture is promoted as separate but linked to environmental, social, and economic pillars (CHCfE Consortium, 2015).

Dessein and colleagues provide a typology of worldviews for culture and sustain-ability that are present in the cultural economics and cultural heritage literature (Dessein et al., 2015). These worldviews are anthropocentric and culture-based. One typology, "culture as sustainable development", proposes that culture acts as the main organizing principle that defines sustainability in all its aspects, in-cluding the environment (Dessein et al., 2015). A culture-centred approach to defining the environment would legitimise any given society's determination of the "correct" tangible and intangible values of natural resources based on their collective "culture". Essentially, this is a restatement of the argument that individual rational choices (utility) can be aggregated as prices in the market, thus arguing that correct pricing solves the problem of environmental degradation. Ecological economics rejects this notion. Joining the debate, Foster and Stagl (forthcoming) defined a new model (Figure 12) that emphasizes the critical role of culture in organizing complex socio-economic systems including SCP from the viewpoint of ecological economics.

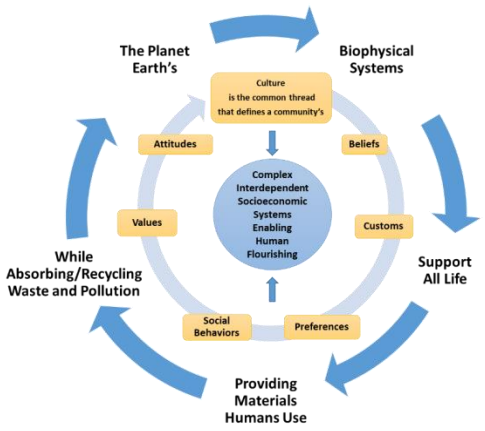

Figure 12:
Placing culture within an ecological economics ontology (Foster and Stagl 2018 forthcoming)

Doing: Analysing strategies for achieving SCP

Coming back to our initial heuristic distinction framing the SCP research presented here, we move on from the conceptualizing research tasks of "knowing" and understanding the complex and intricate systemic nature of SCP to looking into the corresponding areas of "doing" SCP. Starting from the consumer's level, we present a framework of consumer strategies for SCP and provide specific examples for these strategies in the area of food. Next, we discuss the emergent sharing economy practices and the growing platform infrastructure as an example of the role of technology for SCP and progressing digitalization. Finally, we look into the intersection of culture and SCP with the example of the adaptive reuse of cultural heritage sites.

Importantly, in addition to crosscutting themes, SCP research critically analyses new consumption and production practices as socio-cultural movements rather than simply as new products. Many new practices such as urban agriculture, food sharing and digital platforms seem to stand alone. However, as this chapter will show, each is an adaptation to two essential trends, city life connecting people spatially (as discussed in the introduction) and communication technologies connecting people digitally (as discussed in Section 2).

Consumer strategies to mitigate environmental impact

In addition to crosscutting themes, SCP research critically analyses new consumption practices and production patterns. Looking at consumption, there is a wide array of specific actions individuals can undertake to reduce the impact of their lifestyles on the environment. Climate mitigation efforts with regard to consumption have primarily centred on shifting the purchase of products towards low-carbon options (Lorek and Spangenberg, 2014) and/or improving energy conservation practices at home (e.g. switching off lights when leaving a room or adjusting indoor temperature). However, in order to reach the goals of the Paris Agreement, it is crucial to think beyond well-known options and to explore and analyse new opportunities for emissions reduction (Allwood et al., 2011). Schanes et al., (2016b) have developed and presented a conceptual framework that illustrates prevalent strategies and sub-strategies for final consumers to reduce the impacts arising from their consumption practices (Figure 13). The central elements of this framework originate from key concepts such as 'collaborative consumption' (Botsman and Rogers, 2010) or 'connected consumption' (Schor and Fitzmaurice, 2015), the circular economy (European Commission, 2015; MacArthur, 2013), material efficiency (Allwood et al., 2013), prosumption (Ritzer et al., 2012) and finally strong and weak sustainable consumption (Fuchs and Lorek, 2005). The various strategies illustrated in Figure 13 include *Changes of consumption patterns* (reuse, DIY), *Changes in using behaviour* (sharing, repairing/maintaining), and *Changes in disposal patterns* (donating/reselling, recycling). They also encompass strategies that either refer to the purchase of more efficient products, i.e. '*Purchase of efficiently produced products'* and '*Purchase of products that are more efficient in use'* , or to '*Direct reduction'* (consumption reduction, shift between consumption categories, curtailment) (Schanes et al., 2016b).

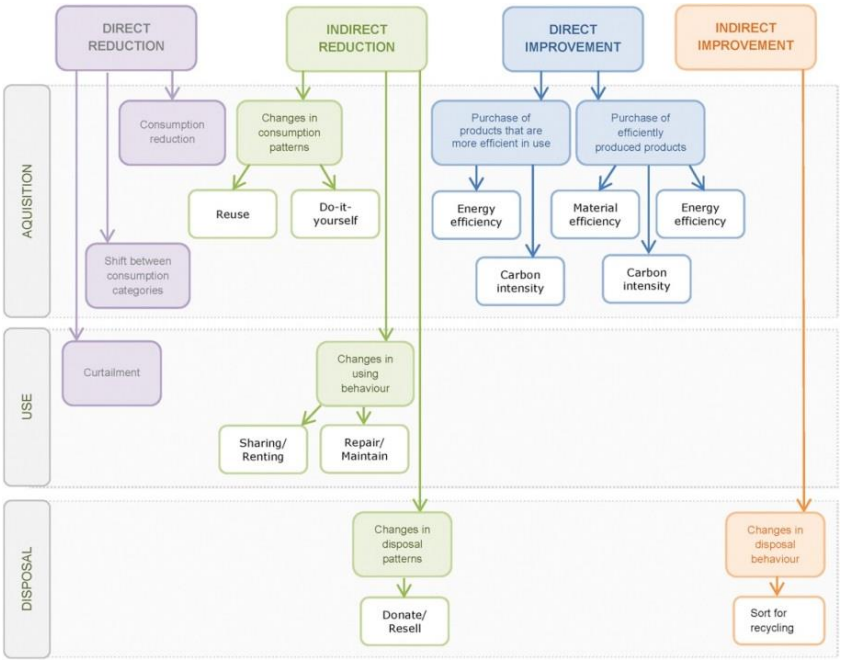

Figure 13:
Framework for mitigation strategies and sub-strategies (Schanes et al., 2016b)

The consumption areas of food, mobility and housing are those with the largest climate impacts and consistently make up the largest shares of GHG emissions (e.g. Hertwich and Peters, 2009; Ivanova et al., 2016). In the subsequent three subsections we take a closer look at one of these consumption categories –food – and discuss some of the above mentioned strategies: *Consumption Reduction* (Food Waste Prevention), *Sharing/Renting* (Food Sharing), and *Do-it-yourself* (Urban Food Growing).

Food waste prevention

Globally, around one third of the global food crops, in terms of food supply, are lost or wasted (Gustavsson et al., 2011). Estimates from Stenmarck et al., (2016) indicate that in the EU-28 88 million tonnes of food are discarded yearly. Food waste and losses create huge environmental, economic and social problems (Mourad, 2016). The impacts of lost and wasted food products on different natural resources is highlighted in a detailed analysis by Kummu et al., (2012). This "trend" of throwing away edible food occurs globally throughout food supply chains. Private households represent the largest food-waste segment (53%) in the whole food supply chain (Stenmarck et al., 2016). Recently, there is a growing understanding that the amount of food produced for human nutrition but not finally consumed is one of the greatest challenges that societies have to meet in order to prevent further climate change (Parfitt et al., 2010). Reducing food waste can save greenhouse gas emissions both upstream, by reducing agricultural production, food preparation and processing, and downstream, by minimizing emissions of the waste management stream. Scenarios for Europe indicate that there is considerable potential for reducing GHG emissions through the reduction

of food waste (Barrett and Scott, 2012). A precondition for implementing the right measures and overcoming the careless handling of food is an improved understanding of the influencing factors that lead to the wastage of edible food. Schanes et al., (2018) therefore provide a comprehensive literature review on the circumstances in which this food waste occurs and give an overview of the main causes of food waste on the household level. The reasons for wasting food in households are manifold and many different factors play a role. In sum, food wastage behaviour can be seen as a complex interrelationship between various factors, e.g. work patterns, family structure, household traditions around meals and the context in which they are performed. This context also includes factors outside of people's control, e.g. the packaging of food products or special offers.

Food sharing

A considerable amount of retail food surplus meets the standards for food donation and has a high recoverability, i.e. it could easily be reused for redistribution (Garrone et al., 2014). Thus, the food sector provides redistribution opportunities for a variety of actors in the supply chain through different interaction modalities (Falcone and Imbert, 2017; Michelini et al., 2018). In addition to longstanding practices of food distribution – i.e. food banks, charitable organizations and secondary markets (e.g. bakery thrift stores) – new forms of initiatives that pick up and redistribute excess food are spreading around the globe. With the rise of emerging information and communication technologies such as web platforms and mobile applications, very diverse food sharing initiatives are emerging. An exploratory database shows that more than 4000 food sharing activities in 100 cities across Africa, Australia, Asia and the Middle East, Central and South America, as well as North America and Europe, exist (Davies et al., 2017). Such distribution channels for food surplus are nowadays seen as a coherent way to manage food that is unsalable in the target market for various reasons, e.g. the internal sell-by date has been reached and/or packages or food t do not comply with market requirements (Giuseppe et al., 2014). Still, little is known about why people actually engage in food sharing and what they want to achieve with their engagement. The case of food sharing in Austria shows a diverse combination of motivations ranging from ideological principles, i.e. ecological and social situations that are perceived as illegitimate, unjust, unfair, and thus "wrong", to more individualistic reasons, i.e. to benefit personally and financially as receivers of free food (Schanes and Stagl, under review). Some especially seek the company of like-minded people and value the community aspect of food sharing, above all the exchange and solidarity with others, while some insist on the importance of challenging society's relationships with food and reinvigorating a culture where food is valued. Others see their participation as way to obtain desired outcomes and reach valued goals, e.g. decreasing the amount of food that is discarded and instead using it for human consumption and/or preventing food surpluses by raising awareness.

DIY – Urban food growing

The growing of plants and the raising of animals within and around cities – a practice commonly subsumed under the term "Urban Agriculture" (RUAF Foundation, 2013) – has gained attention from citizens, urban planners and city governments of the Global North over the last years. Urban food growing activities range from small-scale window farming to community gardening to rooftop farming to more technologically advanced approaches such as hydroponic greenhouses and vertical farming. As these projects narrow the geographical and often cultural distance between food consumption and production, they are often characterized as a type of alternative agro-food network (AAFN) – forms of food provisioning that differ from mainstream models in developed countries and are often characterized by a re-localisation of food systems (Tregear, 2011). Indeed, some argue that the practice of "growing your own food" is necessary to counterbalance the power of globalised agro-food businesses and support environmental sustainability and social justice (Church et al., 2015; Ravenscroft et al., 2013).

Broadly speaking, urban food growing projects are regarded as multi-functional spaces that deliver a range of ecological, cultural, and socio-economic benefits (Lovell, 2010). Indeed, the practice of "growing food in the city" also presents a socio-cultural phenomenon that involves aspects of community, lifestyle, and identity (Dobernig and Stagl, 2015). The increased popularity of urban food growing is indicative of a more general revival of alternative modes of consumption in which the traditional view of consumers as the buyers and users of products is extended, as individuals perform a multitude of roles as co-producers, sellers, consumers and citizens. The heightened interest in these practices also reflects an increased desire and willingness of individuals to engage in co-production and "Do-It-Yourself" (DIY) behaviours. In certain locales, one can observe a notable upsurge in social innovations organized around peer-to-peer provisioning, time-banking, community-based energy, and social lending (e.g. Botsman and Rogers, 2010; Gansky, 2012; Schor, 2011).

Digitalisation: The sharing economy and platforms

Starting with the post-2008 economic crisis, in the last decade the practices of sharing and collaboration have received a lot of attention in relation to our unsustainable consumption and production processes. The sharing economy, defined as a range of online *and* offline practices centred on the highly contested (and evolving) concept of sharing, emerged (Schor, 2014). The boundaries of the sharing economy are indeed fuzzy (Gruszka, 2017), including non-profit *and* for-profit activities that can be split into the following categories: recirculation of goods, increased utilisation of durable assets, exchange of services, and sharing of productive assets (Schor, 2014). The proponents of the concept promise a vision of resource-efficient, connected and emancipated societies – more decentralized, peer-to-peer interactive societies valuing access over ownership - all built on the ideals of cooperation, collaboration and sharing underpinning how we consume and produce (Botsman and Rogers, 2010; Sundararajan, 2016). This vision is to be realized largely thanks to technological developments and the arrival of digital platforms: "digital infrastructures that enable two or more groups to interact" (Srnicek, 2017, p.43).

However, with the growing strength of the large-scale for-profit *Big Sharing (Cohen, 2016)* platforms such as Uber, Airbnb, or TaskRabbit, these visionary takes on the sharing economy have experiences a swelling wave of criticism. This is due to often precarious and exploratory labour conditions, exposing and often deepening social inequality, and reproducing class-, gender- and racial-bias (Cansoy and Schor, 2017; Eckhardt and Bardhi, 2015; Ge et al., 2016; Hardin and Luca, 2014; Ravenelle, 2017; Scholz, 2016, 2017). There is little evidence in research to support lower resource use due to sharing platforms, and the commonly quoted environmental benefits often turn to be a truism, especially once ripple effects and the impact on the economy as a whole are taken into consideration (Schor, 2014). Consequently, digital sharing platforms expose an utter paradox (Gruszka and Novy, forthcoming): they are infrastructures on the grounds of which future scenarios of both platform capitalism (Srnicek, 2017) and platform cooperativism (Scholz, 2016) could flourish. Taking into consideration theimpact of digital platforms on consumption and production (e.g., the already intense changes in urban mobility with Uber, or accommodation services with Airbnb), digital platforms demand special attention for both SCP and sharing economy discourses and practices.

Circular business model for adaptive reuse of cultural heritage sites

One area where new circular business models are demanded is reusing cultural heritage sites for new purposes that fit the needs of society, particularly in urban areas. Business models coalesce new thinking, define critical elements and build strategy for commercial and non-commercial enterprises. Business models must include the interests of users as well. Interest has risen in Europe and internationally on preserving cultural heritage within the context of a transformation to a low-carbon sustainable economy. The idea brings three future-critical research strands together: circular economy implementation to reduce resource use, cultural heritage preservation, and sustainable and regenerative cities. First, these projects can have several environmental benefits, including capturing embodied energy and reductions in carbon dioxide from wholly new construction. For example, the Gasometer project in Vienna was once a natural gas storage site with historical significance for Austria and Europe. Today, it is a city-within-a city and includes housing, offices, shops, a concert auditorium, a post office, and a bank. Second, the new uses conserve the original architecture, cultural and historical elements. The Gasometer project also highlights the third future-critical research stream. Most humans now live in cities. This is a longstanding and increasing trend in human development. Urban buildings are fundamental to human well-being and to our environmental footprint. Over 70% of global carbon dioxide emissions are generated from cities (UN Habitat, 2016). Cities are seeking to be more sustainable and to regenerate economic and social activity in neglected/ abandoned areas. Consequently, SCP research efforts must target multiple aspects of urban life, including the future uses of historic sites of the urban landscape within a circular economy framework.

Discussion and conclusion

The SCP chapter of the Growth in Transition report features the extreme diversity and dynamism present in this research field today by reviewing five conceptualizations (knowing) and six SCP strategies (doing). The five innovative approaches/conceptualizations transect all industries/provisioning systems and reflect macro-level research themes in the field today: the role of the bioeconomy in SCP, the role of technology in SCP, and the role of culture in SCP. The six SCP strategies discussed here apply to key areas of provisioning that contribute to human well-being: food, shelter, and mobility. These strategies are actualizations, at the local level, of the ideals of SCP in the global context expressed in the UN Sustainable Development Goals 11 and 12, for example.

BOX 9:
SUMMARY I

SCP is crucial for achieving a **socio-ecological transformation** towards sustainability and human flourishing.
SCP requires a **paradigm shift** from decoupling towards the notion of spatially coupled production and consumption systems.
SCP requires **monitoring of physical material and energy flows** to support real changes in environmental pressures and social impact.
SCP research is a lynchpin **enabler** to achieve multiple targets and goals in the 20130 **UN SDG agenda**.
SCP research requires **inter- and transdisciplinary** approaches in the interrelated social-ecological systems.
Participative approaches and **critical research** are important to provide evidence for policy to ensure we are moving in the right direction.

Reflecting on the above, it is clear that local action takes place within far-reaching frameworks. Governance can link local policy to macro initiatives. Specifically, local policy needs to set the path towards a just and sustainable society in line with the European Unions' Bioeconomy and Circular Economy initiatives. The key policy challenges are supporting diversity and experimentation with new business models and roles at the local level. Most important, the role of policy is to reflect the dynamism of SCP while guiding practices ever towards resource use reductions on the global, regional and local scale. These policy challenges must be supported by research. As for the future developments of the current research agenda, bioeconomy research covers a wide range of areas: (feedback) risks and resilience dynamics related to a bioeconomy transition in the social-ecological system, material and energy flow analysis of specific and aggregated economic activities, the role of bioeconomy activities - and related pressures and impacts - in the fulfilment of human needs, and potential governance options to foster SCP. Finally, spatial research approaches between global production and consumption systems are of increasing importance for the bioeconomy in relation to geopolitical tensions, environmental inequality, and the relation between urban centres and their rural hinterland.

BOX 10:
SUMMARY II

SCP is a prerequisite for **a sustainable bioeconomy transition** in the social-ecological system. A bioeconomy transition is not a prerequisite for SCP as the biophysical environment is limited.
Changes in **food production and consumption patterns**, in particular reduced animal food intake and food waste reduction, contribute significantly to SCP.
Consumer strategies are paramount in fostering SCP – but we must be cautious not to individualize responsibility and ensure accountability of business and policy.
Culture is a co-determinant of SCP.
Technological development, including the widespread **digitalisation**, has tremendous potential for SCP – but we must foster non-growth driven alternatives.
The term **circular economy** has become a catchall for an eclectic array of SCP strategies and policies– but we must ensure that the goals of these strategies are the overall reduction of natural resource extraction and lessening waste within the environment.

With regards to digitalisation and the rise of (sharing) platforms, three issues are of utmost importance: 1) The concept of governance, control, and regulation and their evolving nature in digital realities; 2) the concept of work – similarly redefined in digital realities, too often strengthening inequalities and precariarisation; and 3) the question of environmental impact of novel digital solutions, largely dependent on resource-intense data. Taken to the level of consumers in SCP, we need a more comprehensive and detailed understanding of *whether* and *how* digitalization (e.g. the use of digital products and services, etc.) may contribute to sustainable consumption practices and reduced environmental impact, and how public policies and policy instruments could contribute to this. Also, and related to this, we need to better conceptualize" digital consumption" as a consumption context and understand its ecological and social impacts (e.g. digital carbon footprint). With regards to the consumption perspective on the circular economy, we need an empirically-grounded understanding of consumer attitudes, behaviours and practices with regards to circular economy concepts and business models in various consumption areas (e.g. clothing, food, electronics, etc.), entailing both driving and hindering factors in adopting consumption practices that support circular economy principles.

In conclusion and reflecting on the future research agenda for SCP, we have seen that the approaches and strategies in this chapter can be contentious and are not without risk. A major risk is that “green” consumption and production will fail to slow and halt overexploitation of the planet, jeopardizing all life. An additional risk is that anthropocentric viewpoints on sustainability only focus on nature’s instrumental value as materials to exploit. Without critical research, history is doomed to repeat itself. Critical research must be the gadfly that prompts government policy and individual and collective action in order to prevent the unsustainable and unjust consumption that is our current legacy.

6
SUSTAINABLE WORK

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Introduction

The sheer volume of entries listed under "work" in the Oxford English Dictionary reveals the historically formidable place of work in our societies and culture. Work can be an "action or activity involving physical or mental effort and undertaken in order to achieve a result, esp. as a means of making one's living or earning money" (OED Online, 2018), but the word also implies a relation to godliness, a "good or moral act or deed considered in relation to justification before God" (ibid.). In terms of labour, "work" refers to "(one's) regular occupation or employment" (ibid.). These multiple meanings of work indicate the relevance of work for numerous aspects of modern life. Work is hence one of the main mechanisms for structuring people's everyday lives, their identity, society, as well as the environment. Given the profound changes required to transform our economy and society in a sustainable direction, the role of work in this transformation must not escape scrutiny. In sustainability research, however, the issue of work has so far been rather neglected. In this chapter, we attempt to integrate social, ecological and economic concerns of work, without limiting the relevance of work to paid labour.

In the following, we first discuss challenges in the context of sustainable work in western societies, including the definition of work and the links between work and social inclusion; employment, growth and energy use; productivity, unemployment and energy use; and the (changing) actors in the field of work. Further, we outline alternative concepts of work, the redistribution and reduction of work and employment, and a social ecological tax reform as possible approaches to address these issues. Finally, we discuss future research avenues concerning the challenges of work for a socially and environmentally sustainable future.

Challenges of sustainable work

Defining work

Public and academic discourses about work are most often limited to concerns over paid activities, i.e. employment or self-employment, or concerned with those who look for a job and are thus defined as unemployed. Work in these terms is also present in the context of sustainable work. For example, SDG 8 addresses decent work together with economic growth and does not refer to valuable but non-paid activities. Eurofound (2015) is interested in sustainable work in terms of the employability of elderly people, hence the sustainability of employment. Care is discussed in SDG 5 in terms of gender equality and unequal contributions of

men and women, but not so much as valuable activities that are in conflict with employment. A rather extensive concept of work, however, can be found in the 2015 UNDP report that explicitly refers to sustainable work as promoting "human development while reducing and eliminating negative side effects and unintended consequences. It is critical not only for sustaining the planet, but also for ensuring work for future generations" (UNDP, 2015, p. 14). In that framework, work is not limited to paid or unpaid activities, but rather concerned with socially just and environmentally sustainable ways of structuring the tasks needed for the reproduction of society.

BOX 11:
OVERVIEW OF CONCEPTS OF WORK

Concept	Definition
Decent Work	Work that respects the fundamental rights of humans as well as the rights of workers in terms of conditions of work safety, remuneration and respect for the physical and mental integrity of the worker in the exercise of his/her employment. It also provides an income allowing workers to support themselves and their families. (United Nations, 2006)
Sustainable Work	Work that promotes human development while reducing and eliminating negative side effects and unintended consequences. It is critical not only for sustaining the planet, but also for ensuring work for future generations (UNDP, 2015, p. 14).
SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value 8.6 By 2020, substantially reduce the proportion of youth not in employment, education or training 8.7 Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms 8.8 Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment 8.9 By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products 8.10 Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all (United Nations, 2015)
SDG 5: Achieve gender equality and empower all women and girls	5.4 Recognise and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate (United Nations, 2015)

In academia, economics is the central discipline focusing on questions around the topic of work. Mainstream economic research conceptualises work in contrast to leisure. Thus, work is an activity with negative utility for which commodity consumption compensates. The significance of work for individual well-being as well as societal development has been extensively demonstrated in the literature. For instance, not only unemployment (e.g. Clark and Oswald, 1994), but also under- and overemployment have been found to reduce life satisfaction (Wooden et al., 2009) and self-perceived health (Bell et al., 2012). Moreover, the presence of a strong work ethic reinforces "having employment" as a fundamental institution for social inclusion in industrialised societies (Weeks, 2011) and creates positive associations with having a job. These aspects of work are a first indication that the description of work as negative utility is fundamentally flawed.

Economists in non-mainstream traditions have used different concepts of work, depending on the school of thought. Some consider work as any activity that creates monetary value, others as a commodity that creates economic value while being consumed; others implicitly discuss work in terms of population shares being employed or unemployed on the macroeconomic level. In many cases, there is little conceptual interest in what work actually is[5]. That economics is relatively little concerned with unpaid or non-monetary concepts of work is shown on Figure 14, which gives an overview of 10 work-related keywords used in economics between 1997 and 2017. For instance, the terms *unemployment*, *employment* and *labo(u)r productivity* are highly relevant. Concurrently only very few articles deal with *care* and *unpaid work*. Current evidence of the concentration and inertia of the economic discipline (Aigner et al., 2018; Aistleitner et al., 2017; Ferguson and Johnson, 2018; Glötzl and Aigner, 2017) suggests that there is little prospect of change in this regard.

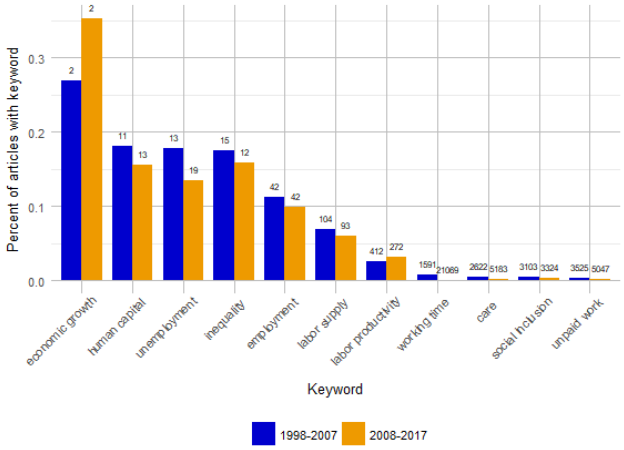

Figure 14:
Percent of economic articles that use keywords relevant for Sustainable Work 10 years before and after 2008. Ordered by rank in 1998 to 2007 (Web of Science, 2018)[6]

[5] For example, orthodox Marxist economists or Post-Keynesian economists.

[6] Top bar label refers to rank of the respective keyword in all keywords in the respective period. Sample size: 138.378 peer-reviewed economics articles. For details on the dataset and method, see Aigner et al., (2018). Own figure and calculation. Data: Web of Science (2018).

Gender or environmentally sensitive perspectives of work have so far only been marginally addressed in economics. However, these appear to be particularly relevant for conceptualizing sustainable work, as they point out that work is not limited to activities that create monetary value. Moreover, a substantive concept of work should also include unpaid activities, which intentionally create socially or environmentally valuable outcomes. In that context, such a definition of work could, for instance, include activities that ensure a regenerative design of the economy (Raworth, 2017) or satisfy human needs independently of their payment (Aigner et al., 2016). This also implies that paid activities that do not meet these criteria are not considered work. An intuitive example here includes illegal but paid activities such as human trafficking. With this in mind, Biesecker and Hofmeister (2010) put forward a twofold concept of work that includes firstly the social metabolism (i.e. the mediation between humans and nature) and secondly the necessary reproduction of society (i.e. the mediation between humans and society). These two dimensions are intertwined and often stand in conflict with each other[7]. An understanding of sustainable work thus includes activities that ensure the livelihoods of human societies by mediating, regulating and controlling metabolic processes (i.e. energy and material flows) and social reproduction (i.e. care); both are essential for human provisioning.

Since economic activity is mostly measured in terms of GDP, the theoretical discussion over work also feeds into political decision making. At first glance, one would assume that when it comes to work, GDP would only include those parts of the economy that involve monetary transactions. In fact the scope of GDP has been broadened to include some non-monetised aspects of work. Until 2009, the "market criterion" (i.e. whether a good or service is *also* produced in paid work despite being produced without payment) was used as a way to include non-monetised but "monetisable" (or in other countries monetised) activities into the System of National Accounts, and thus broadening the scope of GDP (United Nations et al., 1993, p. 94). Since 2009, the "market criterion" is complemented by the "third party criterion" (i.e. activities that produce saleable products by an interchangeable person). Care remains a theoretically contested activity in that context, as particularly the relations between care-giver and care-taker are often very personal, and neither of the two parties is "interchangeable" (Wood, 1997).

Moreover, domestic activities remain excluded from GDP measures due to "the extreme difficulty [of making] economically meaningful numbers" (United Nations et al., 2009, p. 98). Consequently, socially and environmentally valuable[8], but non-market based, activities also remain excluded from GDP, the most economically and politically influential measure of development (Schmelzer, 2016). Furthermore, what is or is not considered work in measuring GDP is adapted to western countries and does not account for country differences (Wood, 1997). In conclusion, GDP growth, employment, or the inclusion of elderly people in paid labour

[7] For instance, the latter is primarily conducted by women and usually referred to as care. Due to transnational care chains, however, women from the periphery often have to conduct paid care in higher income core countries and are forced to neglect their own children (Bauer and Österle, 2013).

[8] Similar arguments have been made by contributions from nature, i.e. the reproduction of fish to society. These have also been excluded from national accounts given the inability of calculating meaningful monetary numbers.

would not be useful indicators for measuring progress towards the goals of sustainable work. Rather, it is necessary to adopt multiple and multi-disciplinary indicators measuring a society's ability to mediate between human economic activity, society and nature – to create and regenerate socially, economically and environmentally valuable outcomes.

Work and social inclusion

Given the relation between work and *godliness*, it is not surprising that employment is important for many other reasons over and above its pure economic value. The academic field of "postwork" focuses on critiquing this work-centrality in modern societies (Seyferth, 2017; Weeks, 2011). The starting point of most critiques is that the institution of wage labour is not natural, but socially constructed. This means that it is also subject to change. As a pivotal social relation in a capitalist society (and its mode of production), wage labour is closely linked to the imperative of growth. Although technological progress since the Industrial Revolution would have allowed for much shorter working hours, these productivity gains have only scarcely been channelled into working-time reductions. About 100 years ago, Keynes (1928) projected that the normal working week would be reduced to 15 hours – instead, the 40 hour workweek continues to dominate. Productivity gains have resulted in un- or underemployment or have been reabsorbed into economic growth via the creation of more work. More and more areas of life, the biosphere, as well as social relationships, have been commodified to respond to the structural pressures of growth and employment.

One of the major reasons for this is that employment serves as the main mechanism for the distribution of income and social inclusion in modern societies. There is much evidence suggesting that markets, and in particular labour markets, do not distribute income in a fair and efficient manner, for instance due to the presence of imperfect competition (Manning, 2003). Institutional economists question whether the concept of the market in general does justice to the production of goods and services by workers (Pirker, 1992). Employment increasingly fails to fulfil its societal functions, considering the high unemployment rate in some European countries and the increase in precarious and atypical jobs. The reluctance to allow refugees to pursue regular employment, for example, also excludes large parts of the population in Europe from employment, income, and, subsequently, from society (Sassen, 2014).

The reliance on employment as a major mechanism for distributing income also leads to the phenomenon of *bullshit jobs:* "a form of paid employment that is so completely pointless, unnecessary, or pernicious that even the employee cannot justify its existence even though, as part of the conditions of employment, the employee feels obliged to pretend that this is not the case" (Graeber, 2018, p. 15). Empirical evidence suggests that up to 40% of all jobs in Holland fall within this definition. Such jobs are present in the public as well as private sector and become more important over time (ibid.). At the same time, if employment serves as the main mechanism to ensure the distribution of income and social inclusion, the extension of employment to the whole population and the avoidance of unemployment through economic growth become central.

Technology, unemployment and the environment

Economic growth has become one of the major indicators of success in the last 60 years (Schmelzer, 2016). As many of the chapters in this report have shown, the expansion of the global economy in terms of GDP has been accompanied by a massive increase in resource use (Krausmann et al., 2009) and atmospheric CO2 emissions (Tapia Granados et al., 2012). Steadily rising output levels, however, are not only required for maintaining political stability and avoiding social conflict through welfare and direct innovations (Mazzucato, 2014), but also for maintaining high employment levels (Antal, 2014). Productivity growth and technological change continuously challenge the maintenance of high employment levels. Rising productivity, as defined by the ratio of outputs to inputs, means that the same output can be produced with less input, which implies that less labour is needed to produce the same amount of goods and services. Subsequently either additional goods are consumed, labour is shifted to low-productivity sectors, or the total number of hours worked is reduced (Jackson and Victor, 2011). If this does not take place, then employees are let go. This theoretical relation between economic growth and unemployment has also been observed empirically (Zwickl et al., 2016). The common policy reaction is to maintain employment and reduce unemployment by fiscal or monetary policy that targets economic growth. At the same time, Warr and Ayres (2012) show that productivity growth has been based on the increased availability and use of primary resources, materials and energy. Labour productivity growth, thus, is not only tied to unemployment, but also to material and resource use.

Historical evidence shows the close link between fossil fuel use and employment. The shift from agrarian societies to coal-based regimes was accompanied by a stark increase in total hours worked (Fischer-Kowalski and Haas, 2016). Concurrently, the use of coal in combustion engines enabled the concentration of production in single large-scale plants and facilitated stricter control, surveillance and disciplining of workers (Malm, 2013; Marglin, 1974), leading to a geographical reorganisation of labour (Harvey, 1996). Only later, and particularly during the oil-based regime in the post-war era, did total labour hours decline, while energy input per hour of labour continued to increase. Hence, mechanical energy began to replace ever-larger sections of blue-collar and manual work. This partial liberation of the industrial workforce enabled the rise in knowledge work, which in turn further accelerated labour productivity (Cordes, 2009). Just as increased mechanisation, technological change and the use of fossil fuel replaced human manual labour, so are ICT (information and communication technologies) now substituting for white-collar knowledge work. Territorial evidence suggests that this second transition is much less energy intensive than the shift from manual to mechanised work during the post-war period. However, taking a footprint approach shows that the service industry is indeed based on outsourced energy-intensive manufacturing facilities (see Chapter 2).

In the near future (dubbed the “Second Machine Age”), ICT and digital technology are set to overtake human knowledge work in a way the steam engine and developments in mechanics helped replace human muscle power (Bernstein and Raman, 2015). The arrival of big data and respective technologies (i.e. machine learning) have enabled the computerisation of a wide range of non-routine cognitive tasks. The McKinsey Global Institute (2017) estimates that global pro-

ductivity increases of 0.8 to 1.4 percent will come about because of technological changes, while Frey and Osborne (2017) argue that 140 million full-time knowledge workers worldwide could be substituted in the future by sophisticated algorithms. At the same time, historical worries about technology-driven joblessness have so far been unfounded, as new jobs and industries have maintained employment (Atkinson, 2016; Autor, 2015). While it remains to be seen whether this will continue to be the case when more and more of knowledge work is replaced, the quantity of jobs lost or created also tells us little about the quality of the new jobs. For instance, new platform-based work arrangements, while potentially creating new and flexible jobs, have been criticised for the lack of social insurance and the undermining of labour standards (Huws, 2014).

Overall, technological change and automation have so far led to the hollowing out of the middle-income sectors of society, with many new jobs being created in the lower income (service) sectors, and a few very specialised jobs being created in the high-end, typically ICT sectors (Goos et al., 2014). Both globalisation and openness to trade, but especially the prevalence of ICT technology, correlates with the polarisation of the labour force between high-income and low-income workers (Michaels et al., 2014). The gap between those with valuable skills on the labour market and the low and middle-skilled employees has been increasing at a steady rate for the last 30 years across industrialised countries (Goos et al., 2014; Karabarbounis and Neiman, 2014). At the same time, the energy intensity of the current replacement of knowledge work remains uncertain.

The distribution of income, paid and unpaid working time

Another aspect of the technological change has been the increased flexibilisation and precarisation of work through the introduction of different platforms and work-sharing apps (for example, Fiver and Uber). The isolation of the individual worker from a collective is a further sign of the very changing nature of work, where emphasis is based on the individual and working life is atomised, with the border between work and leisure being blurred (Fabiane Santana Previtali and Cílson César Fagiani, 2015). This is also in line with trends of increasing inequality in the distribution of working time. Whereas annual hours per employee have declined for most industrialised countries during the last decades, the distribution of working hours among those employed has become more unequal (Jacobs and Gerson, 2006, 2001; Lee et al., 2016). On the one hand, this is due to the rising importance of part-time jobs, the majority of which are performed by women (Tijdens, 2002), and other atypical forms of employment with very low hours. On the other hand, we see a concentration of very long hours among full-time workers (Gerson and Jacobs, 2004).

This rising dispersion in working hours also has an effect on overall income inequality, as earnings are by definition the product of hourly wages and the number of hours worked (Salverda and Checchi, 2015). In Germany, for example, hours inequality has risen considerably since the 1990s and plays an increasingly important role in determining earnings inequality (Checchi et al., 2016). Besides the distribution of hours, it is also the covariance between hourly wages and hours worked that has an impact on income inequality. If the low-paid employees are those working the longest hours, this has an equalising effect on income

inequality. In fact, this was the case some decades ago. However, over time this covariance has changed to a situation where rather those with higher wages work longer hours, while employees with low pay tend to work fewer hours (Checchi et al., 2016; Costa, 2000). The concentration of low-paid jobs at the bottom of the hours distribution can partly be explained by the so-called part-time pay penalty, which particularly affects women (Manning and Petrongolo, 2008; Wolf, 2002).

Women are not only more likely to be trapped in badly paid part-time jobs; they are also responsible for the majority of unpaid household work. Figure 15 shows the daily hours spent in paid or unpaid work by gender and country. The 45˚ line shows for each group whether it spends more time in paid or unpaid work. In none of the countries do men spend more time doing unpaid then paid work. For all but two countries, the opposite is true for women: only in Sweden and Latvia do women spend more time in paid than unpaid work. Thus the figure shows firstly the remaining inequalities in the distribution of paid and unpaid work between men and women and secondly the integration of women into the labour market, not taking into account men pursuing unpaid work. Unpaid work in the definition below includes manual household work, but also care work. Although the participation of women in the labour market has increased sharply over the last decades, women are still doing almost twice as much unpaid domestic and care work as men in Austria. The ratio is reversed when it comes to paid work: time use surveys show that two thirds of paid work is done by men, whereas only one third goes to women (Statistik Austria, 2009). Despite converging time-use patterns between men and women, the patterns are historically relatively constant. Even in countries with the most equal distribution, women do almost 60% of the unpaid work (Gershuny, 2018).

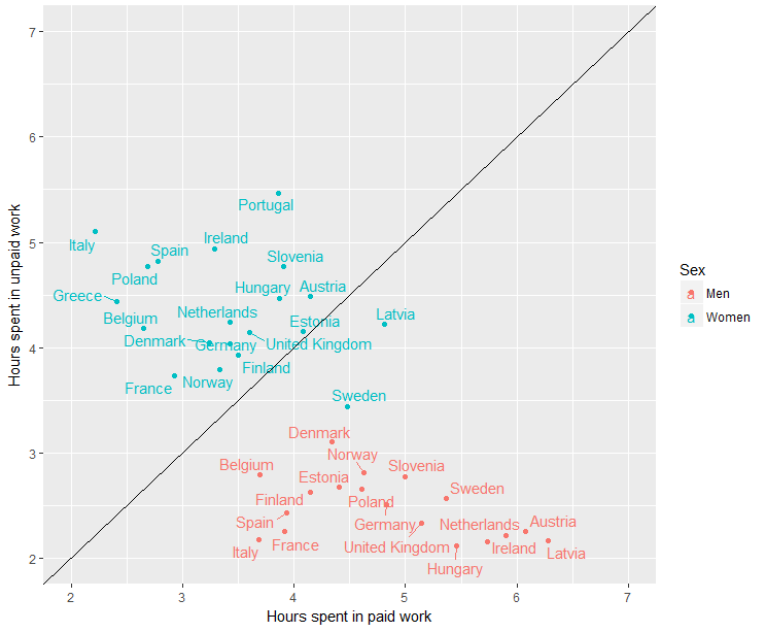

Figure 15:
Hours spend in paid and unpaid work. Most recent time-use data for each country. Own figure based on OECD data (OECD, 2018)

Rising inequality in terms of working hours and income is not only problematic in social terms, but it might also have adverse effects on the environment (for an overview, see Laurent, 2015). With respect to earnings inequality, increasing inequality has been found to foster conspicuous consumption. Whereas top earners engage in resource-intensive status consumption, lower income groups try to emulate these consumption patterns (Bertrand and Morse, 2016; Veblen, 1899). Income inequality also increases the need for economic growth. If economic growth is captured by a small share of the population, additional economic development is needed to compensate the rest of the population (Laurent, 2015).

Rising inequalities in working time and the rise of technology-mediated work also further disinhibit current formations of collective action and trade unionism, although technology perhaps offers the chance of developing new forms of collective action. Class relations, while being hidden by a smokescreen of digitalised individualisation, are nevertheless at the core of the new technology-led polarisation (Wilkie, 2017). In the next section, we discuss the changing actors involved in the field of work.

Actors in the context of work

Society's perception and division of work and labour, as well as the actors involved in the world of paid work, have continued to change and must evolve again to face the many interrelated environmental, social and economic challenges facing us today. As mentioned, since the onset of the Industrial Revolution in the 19th century, industrialised countries have seen an enormous labour productivity increase, fuelled by increased materials throughput. Because of continuing economic growth and societal welfare stemming from increased use of materials, welfarist movements for workers' rights (such as trade unions and workers organisations) of the 19th and 20th centuries were able to secure better working conditions, shorter working hours and other societal benefits (such as education and healthcare) for workers and society at large. Organised labour was historically successful because workers could leverage power over the owners of capital by collectively withdrawing (or threatening to withdraw) their labour. This was predicated on industrial collective action, the forms of industrial work (in factories, mines, shipyards and so forth), where workers could gather and meet, and the capital owners' need for human labour. The state, as the third important actor, had a mediating role in keeping industrial peace between labour and capital. Rising economic growth, productivity and full employment were important conditions that enabled growing well-being and quality of life (Fraser, 1999; Hyman, 2001).

As has been mentioned earlier, rising economic growth is an unsustainable form and means of keeping industrial peace because of its many environmental impacts. Even without taking into consideration these natural barriers to growth, the industrial peace of capital and labour, based on rising productivity, living standards and wage growth, has been in decline. Technological developments and the polarisation of society have shifted the balance away from labour in favour of capital, a process which started in the 1980s (Palley, 2012). This process, which has changed the role of the state from industrial mediator to upholder of free markets, has led to financial deregulation and the financialisation of the economy

in the west, as well as the speeding up of deindustrialisation in core countries. The ability of capital to move (or to threaten to move) production to other countries and the short-termism of new financial capital looking to increase short-term profits abroad – instead of investing at home – crucially weakened the power of collectivised labour, as well as the state (Goos et al., 2014; Hampton, 2015). This destruction of the industrial peace between labour and capital, the decoupling of wage increases from productivity growth, as well as the decreased role for organised labour and the state in mediating working-life have all made it more difficult to answer problems of inequality through traditional methods.

Until now, workers' movements have largely failed to genuinely consider long-term environmental concerns arising from ever increasing production and material use in the face of short-term pay-offs, although there are differences here between countries (especially core-periphery differences) (Hampton, 2015) and positive examples of trade unions trying to make alliances with environmental movements (for the example of Austria, see Soder et al., 2018). In sectors that are not directly impacted by the move away from heavy industry and production (esp. fossil industries), these worker-environmentalist alliances have naturally been easier, while worker-environmental alliances have often not materialised in areas such as the energy sector, where short-term interests are divergent (for the case of UK trade unions in the energy sector, see Kreinin (2018)).

Achieving sustainable work

As discussed in the last section, sustainable work implies, on the one hand, concerns with the mediation between humans, nature and society, as well as social, economically and environmentally valuable outcomes. Achieving these goals in the context of the extensive set of challenges discussed in the last section is not a straightforward task. In the following, we discuss approaches that address these challenges. Firstly, we outline conceptual attempts to make an argument for ensuring time for unpaid activities. Secondly, we discuss welfare state policies that move away from the dependence of social inclusion on paid employment. Thirdly, we outline different approaches as to how to reduce material- and energy-dependency in employment. Fourthly, we outline working-time policies that reduce socially and environmentally harmful work while freeing up time for environmentally sustainable leisure. Finally, we give illustrative examples of actors in the context of work that attempt to address social and ecological concerns.

Concepts of work

We showed that the dominant concepts of work in western societies rely on payment for activities and tasks. Subsequently public discourses and political discussion neglect valuable contributions by non-paid activities. To contrast these developments, authors have suggested approaches that acknowledge contributions from a variety of activities. Haug (2009), for example, suggests a "Four-in-One Perspective" that acknowledges that "wage, reproductive, political and individual development" are equally valuable and need to be addressed in an intertwined way in policy making. Hence, the goal of politics should be to weave the activities together and to allow people to pursue each of them. Similarly,

drawing on the concept of "mixed work" (HBS, 2000), Littig (2015) suggests that the goal of sustainable work is that everybody (can) participate(s) in paid (formal) work, care work, voluntary work and self-provision / education, leading to a balanced state between work, qualification and income both on the individual and the societal level. In addition to these activities, the UNDP (2015) points out that creative expression outside of paid activities should also be considered in the context of sustainable work. In contrast, child or forced labour, as well as trafficked labour, is corrosive and exploitative despite possibly contributing to economic activity measured in monetary terms.

Hence, a precondition to achieve sustainable work is a sound conceptual understanding of employment, where work is not limited to paid activities and where some paid activities are excluded from being addressed in terms of work. For sustainable individual and social development, the distribution of such activities is crucial (see below). The disentanglement of the distribution of income and social inclusion from work – in addition to the reduction of working time – is precondition for the termination of unsustainable/exploitative labour, the transformation of work and the creation of specific activities without increasing political or social instability.

Social inclusion beyond work

As discussed above, the distribution of income and social inclusion rely heavily on wage-labour relations due to the work-centred organisation of western societies. Such an organisation of society is highly dependent on economic growth and thus on increasing energy and material use. Ideals such as autonomy, equality, human flourishing, and environmental sustainability are ignored and non-paid activities receive less-than-needed attention when standing in conflict with paid work. Welfare systems that are not based on employment could overcome these shortcomings. Overall, such a welfare system would ensure the satisfaction of needs through in-kind benefits, cash transfers and the provisioning of environmentally sustainable infrastructure.

Currently, the most widely debated proposal is an unconditional basic income (UBI). While UBI could relieve the pressure of people to enter wage labour, it does not ensure that all citizens would have access to the needed services (e.g. childcare facilities) as markets do not ensure equal access to such goods. Hence, with regard to the provision of childcare, elderly care, or care for people with disabilities, in-kind services such as state financed kindergartens are often more suitable to ensure welfare provision. Moreover, UBI is limited in terms of environmental sustainability, as it could drive economic growth additionally through increased demand. In the case of transport or living costs, the provision of free low-carbon infrastructure through public housing or free public transport could relieve citizens' dependence on wage labour. For additional suggestions, see, for example, Gough, 2016, 2015, 2013; Isenhour and Feng, 2016; Koch and Fritz, 2014; Koch and Mont, 2016.

Socio-ecological tax reform

Current economic growth is largely based on extrasomatic energy (energy not based on human bodies and muscle power) from fossil fuels and is heavily material intense. With raw materials becoming cheaper relative to labour, the priority of companies has been to reduce labour costs instead of striving for more efficient ways to utilise raw materials in production (Fischer-Kowalski and Haberl, 1998; Palley, 2012). One way to reduce the energy and material intensity of the economy is to introduce a socio-ecological tax: a shift away from labour taxation towards material and energy taxation. Such a tax could make labour-intensive services and commodities cheaper compared to goods and commodities that are energy intensive (Ayres and Voudouris, 2014; Warr and Ayres, 2012). The relative shift in prices would encourage efficiency and the development of new resource-saving technology. Such a policy would also increase labour demand, thus possibly reducing unemployment. While the current taxation of labour appears inefficient from an environmental perspective, labour taxes are one of the main mechanisms curbing market income inequalities through their progressive design. Environmental taxes also have distributional effects along several dimensions (OECD, 2006) and possibly affect low-income households in particular, as their share of energy used per euro spent is higher than for high-income households. Basic personal allowances (OECD, 2006) or quotas (Gough, 2013) could prevent regressive redistributive effects.

Working time reduction

Another approach commonly proposed in the context of a socio-ecological transformation is the reduction of paid employment. Shorter working hours might be able to solve several of the above mentioned challenges in achieving sustainable work. Firstly, working-time reduction (WTR) could lower unemployment, as the same amount of work would be distributed among more workers, thereby reducing growth pressures. If paid work were reduced, new jobs might be created, which would relieve us from growing our economies in order to maintain high employment levels (Antal, 2014; Jackson and Victor, 2011; Zwickl et al., 2016). Whether WTR reduces unemployment is one of the most contested issues in economics. Whereas some empirical studies show negative or no employment effects (Hunt, 1999), other studies find positive employment effects (Hayden, 2006; Logeay and Schreiber, 2006). These inconsistent findings can partly be traced back to different model assumptions. However, whether WTR leads to lower unemployment ultimately depends on the specific implementation and the institutional setting (Bosch and Lehndorff, 2001).

Secondly, a WTR might result in a more equal distribution of working hours, thus mitigating the inequality issues outlined above. Under the assumption that WTR creates new jobs, this would increase labour market participation for formerly unemployed persons. WTR could also alleviate the unequal distribution of work between men and women. Establishing 30 hours as new full-time norm would allow more women to work full-time, while enabling men to engage in unpaid care work. Moreover, shorter working hours might also reduce overall working-time inequality, which in turn could lower earnings inequality.

Third, WTR could be a strategy to reduce environmental pressures. Several studies suggest that countries with shorter average working hours also perform better with regard to several environmental indicators, such as energy consumption, ecological footprints, or carbon dioxide emissions (Hayden and Shandra, 2009; Knight et al., 2013; Rosnick and Weisbrot, 2007). These cross-country studies assume, on a macroeconomic level, that fewer working hours lower economic output, which in turn results in lower income, consumption and resource use. However, whether such an effect would materialise depends on the overall number of working hours, which might not change if working hours were merely redistributed. Other positive environmental effects could emerge on the individual level. If WTR were to be implemented without (full) wage compensation, thus lowering employees' disposable incomes, one could expect a reduction in consumption and thus ecological impacts. Also, the increase in available leisure time could be positive for the environment. As resource-friendly activities are usually rather time-consuming, WTR opens up the possibility for more sustainable lifestyles. Although more free time can also be used for resource-intensive activities, such as air travel, several studies suggest that overall environmental effects are positive (Buhl and Acosta Fernandez, 2016; Nässén and Larsson, 2015).

In addition, WTR is also discussed as a strategy to improve individuals' health and well-being. However, the actual effects of WTR crucially depend on implementation. Pullinger (2014), for example, suggests voluntary, flexible WTR schemes over the life course, accompanied by proportional income cuts, in order to achieve both environmental and well-being benefits. The question remains whether WTR can be realised on a broader scale, and whether employees are actually willing to forego an income loss in return for more leisure. Research on Austria suggests that the desire to work less is strongly moulded by social norms, such as the full-time working norm or gender roles. Also personal values, placed either on leisure and family time, or on financial security, are important in shaping working-time preferences (Gerold and Nocker, 2018). Although WTR is traditionally opposed by firms (due to financial reasons or the shortage of skilled workers), there are several good-practice examples of WTR schemes in Austria. A collective case study suggests that a participatory implementation processes, as well as supporting regulatory frameworks, can help to overcome resistance from both employers and employees and to establish successful WTR models (Gerold et al., 2017).

Just transition and beyond

The "just transition" framework (JTF) aims both to revitalise trade unions and to focus on the long-term issues of the environment and how to balance human welfare, jobs and the need for deep decarbonisation. JTF encompasses a number of different social interventions and policies with the final aim of securing jobs and futures for workers, as countries aim to shift away from fossil fuel mining in the field of energy, as well as other production (Just Transition Centre, 2017). Thus JTF is concerned with sustainability-related job-loss as a parallel to technology-related job-loss, which is also set to impact more and more workers. The JTF has become a buzz-word in the international trade union movement, with the ILO also adopting it as a policy goal in 2013 and producing its own guidelines for

a just transition in 2015 (ILO, 2015). Although trade unions have begun to pay lip-service to the idea of a "just transition", in the case of UK trade unions, for example, it is at present not a principal policy when it comes into conflict with other short-term goals (Kreinin, 2018).

While the aims of the JTF policy agenda are admirable, as of yet the policy goals are also somewhat contradictory and untenable – aiming to forge a peace between short-term worker aims and interests and the long-term needs for sustainability, while also being trapped in a mainstream-economics understanding of employment, welfare, and the need for economic growth. Pursuing a kind of second New Deal for environmental sustainability with heavy investment into green technologies (and thereby new jobs for workers in the green economy), the ILO guidelines under 19(b) and 19(d), respectively, suggest countries align "economic growth with social and environmental objectives", and "invest public funds in greening the economy", while the other guidelines focus on skills development, social protection, as well as active labour market policies, amongst others (ILO, 2015). Although the JTF offers a good starting point for worker-environmental alliances, as the guidelines show, the suggested policies do not challenge the primacy of economic growth as a way of provisioning human welfare and keeping unemployment at bay. The report mentions green growth as a panacea to the problem of environmental impacts stemming from increased production, but since the absolute decoupling (see previous sections) of environmental impacts from increased economic growth has been shown to be impossible, this JTF overall fails to address issues of deep carbonisation. It also fails to move away from the dogma of work and the *godliness* of work, aiming for full (albeit "green") employment and utopian green-growth, rather than questioning the unsustainable foundations on which our current work-centric economy and society are built. To offer a realistic alternative for a sustainable future for workers, the JTF as it currently stands must evolve (through the ILO or trade union alliances) to offer realistic policy goals and aims rooted in a critical understanding. Since "climate change challenges the dominant political economy all the way down" (Hampton, 2015, p. 3), avoiding conflict (including failing to challenge issues which might affect some workers in fossil-intensive or otherwise destructive industries) means failing to confront the conditions that created climate change in the first place. Unions must defy this need to protect the narrow interest of their workers and accept that conflict is inherent in transitioning to a more sustainable future (Kreinin, 2018; Lundström, 2018; Snell and Fairbrother, 2010).

Research outlook

Important political and policy questions about the future of work in relation to technological change remain and there is undoubtedly an urgent need (and plenty of scope) for further scholarship on the issues that have been briefly mentioned in relation to sustainable work – at the crossroads of employment, the economy, society and nature. The crucial issue and base for further research on the topic is how to move away from current unsustainable growth and work-centrism in favour of more sustainable goals, as well as how to terminate certain fields of work (i.e. fossil industry), transform the field of work, and create sustainable activities for people – all without increasing political or social instability. It is clear that produc-

tivity growth based on technological change and automation (and the increasing use of fossil fuels) cannot continue endlessly, as societies are already consuming more than the planetary systems can handle. The role of work, the work ethic and work-centrism in society for income generation, meaning-creation, and societal positioning must evolve – but *where to*?, *how*?, and *in which manner?*, are some of the urgent questions whose answers have not yet been fully articulated.

An important social question related to technological change is whether the benefits of technological development and productivity growth, as well as the decrease in human labour hours needed, can be fairly divided in society. Will further technological change simply lead to more forced unemployment and further widen the gap between those with economically desired skills and those without? What happens to those who lose their jobs, and must we adhere to current cultural understandings of work as godliness, striving for full employment, although most of the newly created jobs are low-skilled and in effect meaningless? Multi-disciplinary research in many different academic fields (including economics, sociology, psychology, and philosophy) could help us in understanding, measuring and finding new policy possibilities and avenues for change. From an environmental point of view, future research should take into consideration the extent to which efficiency increases based on technological advances add to environmental pressures while replacing human labour.

7
TRANSFORMATIVE LEARNING

CHRISTIAN RAMMEL AND PETRA BIBERHOFER

For the treatment of global challenges such as climate change, biodiversity loss or social inequality, education plays a central role. It has the potential to initiate and support learning processes for sustainable solutions across all SDGs. Educational pathways are socializing entire generations, shaping worldviews and values, and are also crucial when it comes to particular skills and competencies needed for the world of work – be it within companies, NPOs, NGOs, sustainability-driven entrepreneurs[9] or any other form of organization.

BOX 12:
SDG 4 – QUALITY EDUCATION

Education is one of the essential prerequisites for the fulfillment of the entire 2030 Agenda. Education, therefore, has a key role to play in the vision of a just, peaceful and sustainable society. The world community has set its own goal (SDG 4): "To ensure inclusive, equitable and high-quality education and to promote opportunities for lifelong learning for all". All education partners worldwide must participate in order to achieve this goal (United Nations, 2015).

The role of education for social-ecological transformation is emphasized in particular in SDG 4, quality education (see box), but also in various other key policies (UNESCO 2014, 2017; WBGU 2011). One central question in this regard is what kind of education is needed to acquire knowledge and skills needed to promote sustainable development and to initiate and foster socio-ecological transformations. Certainly, there is awareness that it has to be education different from the kind provoking the current state of unsustainability. Moreover, the way education is defined determines structural macroeconomic conditions. This is especially relevant in the context of the equipment of educational institutions aimed at facilitating the integration of learning contents related to the topic of sustainability into existing learning situations such as school classes or university courses. It also opens possibilities for innovative didactic methods that create new learning spaces going beyond formal educational settings or traditional teaching approaches based on direct instruction. Understanding education as a process and

[9] Sustainability-driven entrepreneurship integrates the dimensions of sustainable development into the core business model of companies. Based on cross-sectoral collaborations, sustainability-driven entrepreneurs want to initiate and contribute to transformation towards a more just and fair society and try to create a positive social and ecological impact (for further details see chapter below).

not as an instrument for behavioural change is at the core of the paradigm, which is referred to here as transformative learning. UNESCO's (2011) approach to education for sustainable development (ESD) is very much connected to this understanding:

> "*ESD is a learning process (or approach to teaching) based on the ideals and principles that underlie sustainability and is concerned with all levels and types of learning to provide quality education and foster sustainable human development - learning to know, learning to be, learning to live together, learning to do and learning to transform oneself and society.*"

Transformative learning and social-ecological transformation

An important starting point for understanding the concept of transformative learning is to examine the characteristics of prevailing problems like climate change, desertification or poverty –referred to as highly complex and uncertain issues. Clearly, they cannot be solved by simple solutions, as multiple stakeholders are involved in producing current states of unsustainability and often have conflicting norms, value frames and beliefs regarding the actual subject of transformation. That is why transformative learning strategies are essential in allowing people to understand complex systems and to engage constructively and responsibly with increasing complexity and uncertainty of future trends. Transformative learning is characterized by a quality shift in perception and meaning-making, which brings the learner to question and reframe his/her worldviews, assumptions and habits (Mezirow 1997, 2003).

BOX 13:
DEFINITION TRANSFORMATIVE LEARNING

Transformative education can be defined as teaching and learning that involves… (O'Sullivan et al., 2002)

- A deep structural shift in the basic premises of thought, feelings and actions
- A shift of consciousness that alters our way of being in the world
- Understanding ourselves, our self-locations, and our relationships with others in the world
- Understanding relations of power in interlocking structures of race, class and gender
- Envisioning alternative approaches and possibilities for social justice.

Notably, contrary to the classical emphasis in traditional educational concepts on pure knowledge acquisition, transformative learning involves a structural shift in the basic premises of feelings and the way we understand ourselves, and, most of all, it questions our relations with other humans and the world around us (Box 1 based on O'Sullivan et al., 2002). Thus, what is essential is the holistic understanding of social pedagogy connecting heart, hands and head and the develop-

ment of factual knowledge ("knowing-that") and procedural knowledge ("knowing-how"). In other words, one has to integrate a cognitive domain (head) to critical reflection, the affective domain (heart) to relational knowing and the psychomotor domain (hands) to engagement (Figure 16). Consequently, transformative learning processes are driven by personal engagement and stimulate critical experience-based reflection (Taylor and Cranton, 2012).

In contrast, the traditional emphasis solely on cognitive learning is neither sufficient to incorporate the principles and objectives of ESD nor able to engage with real qualitative change (Figure 16). Essentially, the search is on for learning approaches dealing with the inherent contradictions of social-ecological transformation, which empower learners to engage in self-organized action and enable people to transform structural conditions. While transformative learning is often presented as a mode of change on the part of an individual (albeit as part of society), the transformation to sustainable development clearly requires societal change (Balsiger et al., 2017). Transformative learning addresses these challenges as it centres on the question of how learning processes with adults can change their attitudes, preconceptions and meanings, hence providing space for autonomous and critical thinking and competence to judge. Further qualities of transformative learning and the competences it supports and creates are abilities such as participating in interdisciplinary teams, cooperative and creative problem solving, bridging theories with practice or actively dealing with conflicting values, knowledge domains and legitimated interests (Thomas, 2009; Taylor and Cranton, 2012).

Figure 16:
Aspects of Education for Sustainable Development (translated from Stelzer et al., 2012)

Subsequently, transformative teaching encourages the learners to explore epistemic change, while providing a learning environment that initiates an open dialogue between different disciplines and stakeholders outside the formal classroom settings. Therefore, the learning environment cannot be limited to formal education (universities and schools) but has to be open for informal and non-formal education (e.g. of community leaders, media, local businesses or NGOs). Particularly when teaching is centred on social-ecological transformation or topics of

sustainability, it is suggested to enfold it within the transdisciplinary setting between science and society and to aim at concrete experience and challenges of developments at various scales.

Transformative learning environments

The structural embedding and strategic implementation of transformative learning approaches into current educational institutions is challenging, and educational institutions struggle with integrating them in their established institutional settings. Hence, practical insights on how transformative learning can be organized, structured and institutionalized are crucial in order to provide comprehensive transformation strategies. Engagement in transdisciplinary collaboration, referring to multiple stakeholder settings linking different backgrounds, has great potential for initiating transformative learning based on integrated conceptual understanding (Pennington et al., 2013).

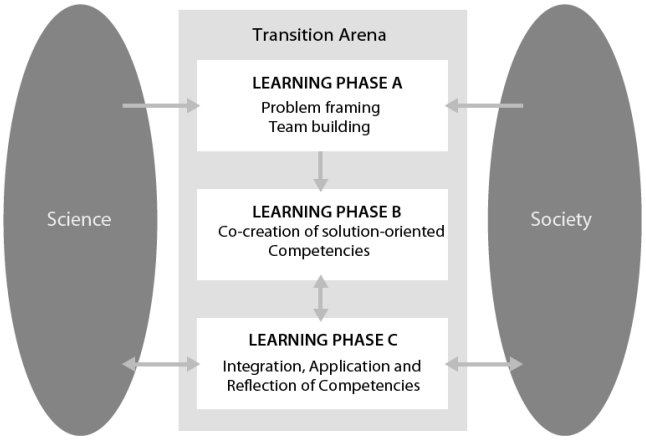

Figure 17:
Phases of transdisciplinary learning processes (adapted from Lang et al., 2012)

In this context, transdisciplinary approaches should:

> […] *grasp the complexity of problems, take into account the diversity of life-world and scientific perceptions of problems, link abstract and case-specific knowledge, and develop knowledge and practices that promote what is perceived to be the common good* (Pohl and Hirsch Hadorn, 2007, p. 20).

In short, transdisciplinary processes provide opportunities for collaboration between science and society, facilitating learning in different phases. Ideally such learning processes are constituted by 3 phases: joint problem framing (Phase A), co-creation of solutions (Phase B), and knowledge integration, application and reflection (Phase C) across different fields of interest (Figure 17).

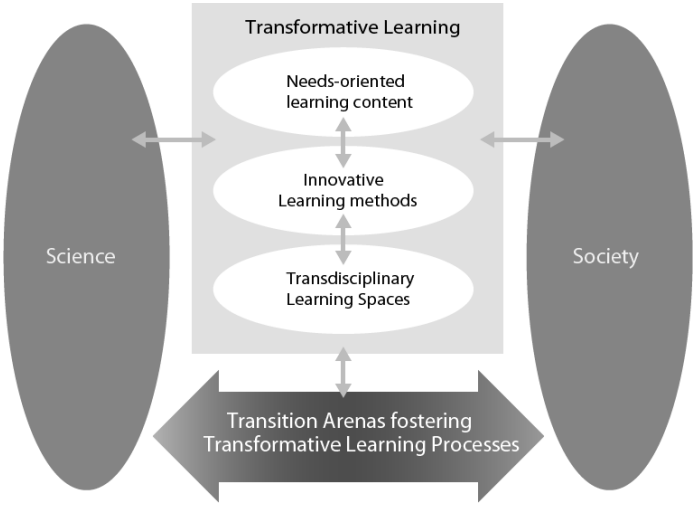

Figure 18:
Transformative Learning Processes at the science-society interface (adapted from Biberhofer et al., 2016)

Consequently, if universities fulfil their often-stated role as major driving forces of sustainable change (Scott et al., 2012), they must change their central functions and the ways they interact with the world outside of classrooms and laboratories (Lozano 2006). In the area of teaching and learning, this transformation has started through the integration of sustainability-related topics into existing curricula (Thomas 2009). Nevertheless, in many cases, curriculum change is limited to the question of "what" to teach, but does not sufficiently tackle the related issue of "how" to teach (Biberhofer and Rammel 2017). Curricula need to reflect sustainability issues at the science-society interface. Hence, needs-oriented learning content and a pedagogical framework based on innovative learning methods and transdisciplinary learning spaces, which relates to ESD and transformative learning, are needed (Figure 18). Change on both levels is seen here as necessary for universities to use their potential to make their local contexts more sustainable and graduates more capable in key competencies for sustainable development (Biberhofer et al., 2018). In short, if universities want to provide transition arenas (Figure 17) fostering transformative learning processes (Figure 18), teaching must aim at the process of transdisciplinary problem-based learning rather than the accumulation of pure knowledge (Thomas 2009). To be effective, such transdisciplinary approaches to learning and teaching linked with ESD are required to become a conceptual and systemic part of universities' culture of education.

Sustainability-driven entrepreneurs as agents of change

As we have shown above, universities have the potential to become drivers for ESD and could constitute fundamental vehicles for exploring, testing, developing and communicating conditions for socio-ecological transformation (Disterheft et. al 2013; Leal Filho, 2012). This focus on transformation, i.e. on transformative learning processes, is key to ESD and is also at the very heart of the idea of a "sustainable university". In fact, sustainable higher education has not only a strong transformative aspect, but also the explicit mission to initiate socio-ecological transformations (Disterheft et. al 2013). In order to drive or influence socio-

ecological transformations towards a post-growth society, universities must extend their activities beyond a still prevailing narrow concept of sustainability and head towards educating a new generation of agents of change (Wals, 2011 Leal Filho,2012).

However, this focus on teaching, motivating and empowering students to act as agents of sustainable change still seems to be a rare perspective within our universities. Indeed, higher education institutions are still locked into the pitfalls of transmissive education (Wals, 2011; Shriberg, 2002) and predominantly accentuate knowledge based on economic values. The reason for this undesired situation can often be found in the existing orientation towards an entrepreneurial model of universities (Yarime et al., 2012), which serves as a knowledge factory for economic growth and follows traditional, mechanistic mental frames of education (Lozano et al.2006). This focus on transmissive concepts of education paired with the focus on economic growth is found all over the world in recent programs of entrepreneurial education. Corresponding approaches of teaching are based on a concept of education that aims to prepare for a specific economic model, driven by the purpose of replicating certain mind-sets and improving them along pre-selected economic and technological paradigms over time. Jickling and Wals (2011) describe the purpose of such education as schooling and as the social reproduction of existing norms and unquestioned assumptions. Notably, the norms that underpin the objectives of such teaching and learning are hidden in the subterranean fundament of education – just as, in a similar way, the norms and assumptions of economic growth are often well hidden in the subterranean fundament of public, as well as scientific, discourse.

However, there is a growing tendency to transform entrepreneurial education based on the principle of ESD and to support transformative education in order to empower a new generation of entrepreneurs as essential perquisite of sustainable change. This shift in entrepreneurial education reflects an increasing awareness that the global challenges of the Anthropocene and their subsequent translation into the 17 SDGs require new types of entrepreneurs as well as a related new culture of making business (Lans et al., 2014). In this context there is a growing body of literature that addresses the advent of a sustainability-oriented type of entrepreneur and that emphasises new topics such as sustainability business 3.0, impact entrepreneurship, or sustainability-driven entrepreneurs (Biberhofer et al., 2018; Dyllick and Muff, 2016, Schaltegger and Wagner, 2011). To emphasise the implicit values that "drive" entrepreneurial creativity towards socio-ecological transformations, the RCE Vienna uses the term "sustainability-driven entrepreneurship" in this discourse.

In short, sustainability-driven entrepreneurs not only try to reduce the negative impact of their business, but also explicitly strive to make a positive impact for society and the planet (Dyllick and Muff, 2016) and can be characterised by three

important aspects, which distinguishes them from entrepreneurs caught in "business as usual" or Corporate Social Responsibility related business:

- **Impact**:
  Sustainability-driven entrepreneurs want to achieve positive social and ecological impact.
- **Transformation**:
  Sustainability-driven entrepreneurs want to contribute to / initiate socio-ecological transformation towards a more sustainable and fair society.
- **Cooperation**:
  Sustainability-driven entrepreneurs head for cross-sectoral collaborations with other business, communities, policy makers and civil society.

For entrepreneurial education, this new focus on sustainability-driven entrepreneurs provides an obvious challenge and demands new transformative learning environments to complement the usual approaches of learning and teaching in this area.

New transformative learning environments in entrepreneurial education: The example of Playpark Sachsenplatz

Striving to empower a new generation of sustainability-driven entrepreneurs, more research on the supporting conditions for transformative learning environments in entrepreneurial education is needed. Among others, transformative learning environments are built on transdisciplinary approaches to learning and teaching, which inspire critical reflection, aim for qualitative change, and include a strong focus on open dialogues between different knowledge domains (Figure 16). The transdisciplinary fundament of such learning spaces creates opportunities for responsive and transformative learning and leads to new mind-sets and competences, rather than promoting fixed behavioural responses (Krasny et al., 2010). In many cases, such new learning settings include social learning, self-organisation, reflexivity, participation and collaborative learning processes across science and society. They appear in formal, non-formal and informal levels of education and can range from temporary and locally based service learning projects (Biberhofer and Rammel, 2017) to social initiatives like transition towns (Aiken, 2012) to new incubators for sustainability-driven start-ups like the Playpark Sachsenplatz, which is coordinated by the RCE Vienna at the WU Vienna.

As a start-up academy for sustainability-driven entrepreneurs, the Playpark Sachsenplatz was created within the INTERREG project "*Central Europe Regional Innovation Ecosystems Network*" (CERIecon) together with the Vienna board of schools. The Playpark provides a learning and development space for young sustainability-driven start-ups and future entrepreneurs who want to tackle sustainability challenges through their entrepreneurial creativity. Every year, 20 start-ups benefit from a transformative learning environment that reflects

a transdisciplinary mosaic of coaching, multi-stakeholder workshops, teaching, networking and mentoring. The transformative learning environment of Playpark Sachenplatz expresses the following characteristics:

- An explicit focus on **self-organization** - the involved start-ups shape and organize their working and learning environment to a great degree – they define "how to play" in the Playpark;
- A high amount of **peer-to-peer learning**, where the start-ups share their knowledge and expertise and work together on various projects;
- A strong focus on **collaboration with different stakeholder groups of the region** – such as NGOs, schools, researchers, etc.;
- An **open house rule of a learning and development space** – the Playpark is also a place for local and international events, communication and mutual social learning;
- A strong focus on **social innovation** and **social learning with the internal and external community of the playpark.**

The further development process of the Playpark is accompanied by current research of the RCE Vienna aiming at the appropriate institutional and pedagogical elements to provide a transformative learning environment. This on one hand provides necessary guidance, teaching and support, and on the other hand gives enough room for playful, self-organised learning and interacting with the communities in the neighbourhood.

The advent of new approaches to transformative learning and new emerging transformative learning environments for sustainability-driven entrepreneurship such as the Playpark Sachsenplatz provides promising opportunities for socio-ecological transformations towards a post-growth society. However, these new complimentary approaches in entrepreneurial education are still marginal and not yet in the mainstream of learning and teaching in higher education institutions. Thus, the degree of change and research at our universities required to empower future entrepreneurs to act as agents of change is significant. Change is needed in the way we understand the purpose of our higher education and the way we tackle the balance between transmissive and transformative approaches of learning. Such a change could enable universities to prepare young entrepreneurial minds to create new ideas and new collaborative competences to govern sustainable transformations towards a post-growth society.

Policy implications

Facing SDG4, policymakers are asked to understand the societal role of universities in a different light and to support conditions for transformative learning across various interfaces between science and society. This is of special importance for entrepreneurial education and for educating a new generation of entrepreneurs, which drive socio-ecological transformations towards a post-growth society. To tackle this challenge, we stress the following policy implications:

- **Transformative learning** needs to be reflected at all levels of educational policies, as we need learning for change and not only "conformative" and "transmissive" learning processes.
- The concept of **entrepreneurial universities as well as the purpose of entrepreneurial education** should be extended and must reflect the new culture of sustainability-driven entrepreneurs and steer away from supporting business as usual.
- **Encouraging transdisciplinarity in education** implies significant reform in the current education system while emphasising the need for open dialogues and knowledge exchange (supplementing the uni-linear knowledge transfer) across science-society interfaces.
- **Evaluation and assessment strategies for universities and research** should not only be focused on learning outcomes, but must also integrate learning processes as well as the societal impact into evaluation strategies. Additionally, this orientation towards impact and socio-ecological transformations should be reflected in the related funding schemes for research and higher education.

8
BEYOND THE STATE OF THE ART

FRED LUKS

Against the background of our analyses and the aforementioned needs for further research in the six areas elaborated, we also want to point out a few areas where additional research is needed that reach beyond those already identified. In particular, the manifold and complex links between our topics are certainly a field where more research is required – research that must, due to the nature of the problems and issues involved, be of both inter- and transdisciplinary character. The interconnections between the topics – resource use and environmental policy, macroeconomics and economic policy, the implications of climate issues for financial topics such as regulation of the financial industry, models of creating patterns of sustainable consumption and production, the challenge of sustainable work in a world shaped by technological shifts and ecological limits, and the role of learning and education for a socio-ecological transformation – have been sketched out, but they deserve further research that clearly reaches beyond the scope of the present paper. One particularly interesting field for deeper research is certainly the science-policy interface in the fields of economy, ecology, and sustainability.

Policy support to ensure meaningful research

It is clear to us that the topics, approaches and methods covered in this report must be further elaborated. Research is by definition an ongoing process without a pre-defined end. In the present case, the urgent need for prompt action in respect to the challenges of the transformation towards sustainability make it particularly important that research on the chances and limitations of sustainable development is acknowledged, valued and supported.

From our perspective, there are at least two ways in which policy must support meaningful research. For one, taking such research seriously is a visible and impactful way of supporting scientific endeavours. Research on sustainability topics has gained increasing attention and impact during the last decades. Climate policy, for example, cannot be designed without the efforts of thousands of scientists and the activities of the International Panel on Climate Change. However, the achievements of climate policy today are far away from what is deemed necessary by the overwhelming majority of climate researchers. Often science cannot be translated directly into policy, but at least policy should take the insights and warnings from science seriously, even when such insights and warnings contain “inconvenient truths”.

The other important and indeed necessary support is, of course, funding. The European Union and its member states have a fine tradition of supporting

research. It is obvious that, facing the challenges of a socio-ecological transformation, this kind of support must continue and should indeed be expanded. We have shown many examples of how scientific work can provide policy makers, other stakeholders and indeed society as a whole, with meaningful knowledge about the interaction of economic activities and ecological (un)sustainability. It seems obvious that there are many other sustainability-related scientific challenges that are in need of financial support from both the public and the private sector. This shared responsibility between science, policy, businesses, consumers, and civil society will certainly be a crucial factor for the success of a socio-ecological transformation that leads to a global development that can legitimately labelled “sustainable”.

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