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Published in:

Globalisation, New and Emerging Technologies, and Sustainable Development

DOI (link to publication from Publisher):

[10.4324/9781003037750-18](https://doi.org/10.4324/9781003037750-18)

Publication date:

2021

Document Version

Accepted author manuscript, peer reviewed version

[Link to publication from Aalborg University](#)

Citation for published version (APA):

Gregersen, B., & Johnson, B. (2021). The measurement and performance of the Danish innovation system in relation to sustainable development. In J. L. Christensen, B. Gregersen, J. R. Holm, & E. Lorenz (Eds.), *Globalisation, New and Emerging Technologies, and Sustainable Development: The Danish Innovation System in Transition* (pp. 252-266). Routledge. <https://doi.org/10.4324/9781003037750-18>

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13. The measurement and performance of the Danish innovation system in relation to sustainable development¹

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Abstract

Chapter 13 discusses how well does the Danish innovation system perform in relation to sustainable development, and how this performance is assessed. Using the United Nations' 17 Sustainable Development Goals (SDGs) and related targets as overall performance measures for sustainable development the Danish innovation system is performing relatively well but still with major challenges before the 2030 targets are obtained – especially in relation to sustainable cities, consumption, production, climate action and 'life below water'. It is argued that although the 17 SDGs may serve as important guideposts and wake-up calls for policy action, the notion of the learning economy where learning and capability building are at the centre provides a relevant supplementary starting point for formulating policies for a transition to a more sustainable development path. The chapter turns finally to a wider perspective on sustainable development and raises the question if the meaning of sustainable development needs to be rethought in the Anthropocene era with significant human impact on the Earth's ecosystem.

13.1 Introduction

It is increasingly acknowledged that limiting climate change, biodiversity loss, pollution and other major environmental problems requires fundamental changes in the structure and development of production and consumption of goods and services (Stern 2006, 2015; Rockström 2015). The conviction that 'sustainable transformation' of contemporary societies is necessary for the long-term survival of human civilization has probably never been as firm and widespread as at present. It is obvious that new knowledge and innovation are needed to realise developments towards sustainability (Fagerberg et al. 2015; United Nations 2019a). It is, however, important to stress that not only technological innovations are necessary. Without social innovations, institutional innovations and policy innovations it will not be possible to make such a sustainable transition. This means that innovation systems need to be well

¹ To be published in Christensen, J. L., Gregersen, B., Holm, J. R. and Lorenz, E. eds. (2021) *Globalisation, New and Emerging Technologies and Sustainable Development – the Danish Innovation System in Transition*. Abingdon: Routledge.

functioning in order to support the necessary transformation towards more sustainable societies (Markard et al. 2012; Fagerberg 2018). In other words, the performance of national innovation systems should, thus, reflect how well the innovation system contributes to sustainable development.

Nevertheless, performance is not a simple concept. It can be delineated and measured in many different ways. First, performance may be delineated both narrowly and broadly. A narrow definition of a national innovation system may focus on the research and development system, and the meaning of performance is then rather straightforward. It can be thought of as research and development-based technical product and process innovations. Performance indicators are, for example, scientific publications, patents and new products and processes as measured by innovation surveys. If this approach is applied to sustainable development it could be specific scientific publications, patents and new products and processes related to any of the 17 Sustainable Development Goals (SDGs), for instance the so-called ‘green patents’ analysed in Chapter 12 (this volume) by Østergaard et al. (2021).

Second, it is important to distinguish between how good the system is at producing goods, services and other things we value in a sustainable way and how good it is at generating the capabilities in forms of competences, skills and experiences, needed to produce such values (Teece et al. 1997). There is, thus, a difference between a utility-based and a capability-based approach. In a long-term sustainable development perspective, the capability to learn and innovate is, obviously, crucial and a discussion of innovation system performance has to reflect this.

Against this background the overall question raised in this chapter is how well does the contemporary Danish innovation system perform in relation to sustainable development? To answer this, we start in Section 13.2 by taking a closer look at the United Nations 17 SDGs and related targets as overall performance measures for sustainable development. The SDG performance measures play a central role as policy-informing tools, as they reflect the 2030 commitments at the national level. Although the prevailing monitoring of how far or how close the Danish innovation system develops to reach the 17 SDGs at the national level may serve as important signposts and wake-up calls for policy action, we argue in Section 13.3 that these measures should be supplemented by a *learning* and *capability building* approach to performance measurement. Capability building is understood here as building capability and

capacity to enhance knowledge, competences, skills, experiences and institutions to be capable of propelling a transition to a sustainable development path. In Section 13.4 we widen the perspective on sustainable development and raise the question if the meaning of sustainable development needs to be rethought in the Anthropocene era with significant human impact on the Earth's eco- system. Section 13.5 discusses some overall policy implications and concludes the chapter.

13.2 UN Sustainable Development Goals as performance measures

13.2.1 OECD and UN performance assessments of Denmark in relation to the SDGs

In the literature, sustainable development is conceptualised in different ways. Very generally, it may be thought of as the ability of the economy to function within the capacity provided by the Earth's ecosystems (Dietz and O'Neill 2013). Referring more specifically to human needs the Brundtland report defined sustainable development as development that 'meets the needs of the present generations without compromising the ability of future generations to meet their own needs' (UN 1987 Brundtland report). It can also be defined and operationalised, specifically and broadly at the same time, as the United Nations 17 SDGs. This section takes its point of departure in the latter.

The 17 SDGs¹ adopted in 2015 in the '2030 Agenda for Sustainable Development' are accompanied by 169 sub-goals or targets describing more specific goals and actions in order to stimulate a transition towards a global sustainable development. To be able to measure status and assess development, a global indicator framework was developed by the Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs) in 2017. Annual refinements of indicators have taken place, and in the 2020 report the indicator framework consists of 247 indicators of which 231 are unique indicators as a few indicators are repeated under two or three different targets.²

The final selection of sub-goals and indicators is of course a pragmatic solution based on the one hand on what makes sense from an overall perception of 'sustainable development' including what type of indicators are relevant and what data is available on a systematic and worldwide scale, and on the other hand, what is negotiated and accepted politically by the 193 UN member states. Although the 17 main goals and the related 169 sub-goals or targets are

global targets meant for all countries, it is clear that some (or most) are easier to achieve for high-income countries (mainly situated in the North) than emerging economies or low-income countries (the latter mainly situated in the South). For these reasons it is also stressed that countries should supplement the UN-monitoring activities with more specific sub-goals and indicators relevant as signposts for country specific actions. We return to a Danish example of supplementary indicators later in this section.

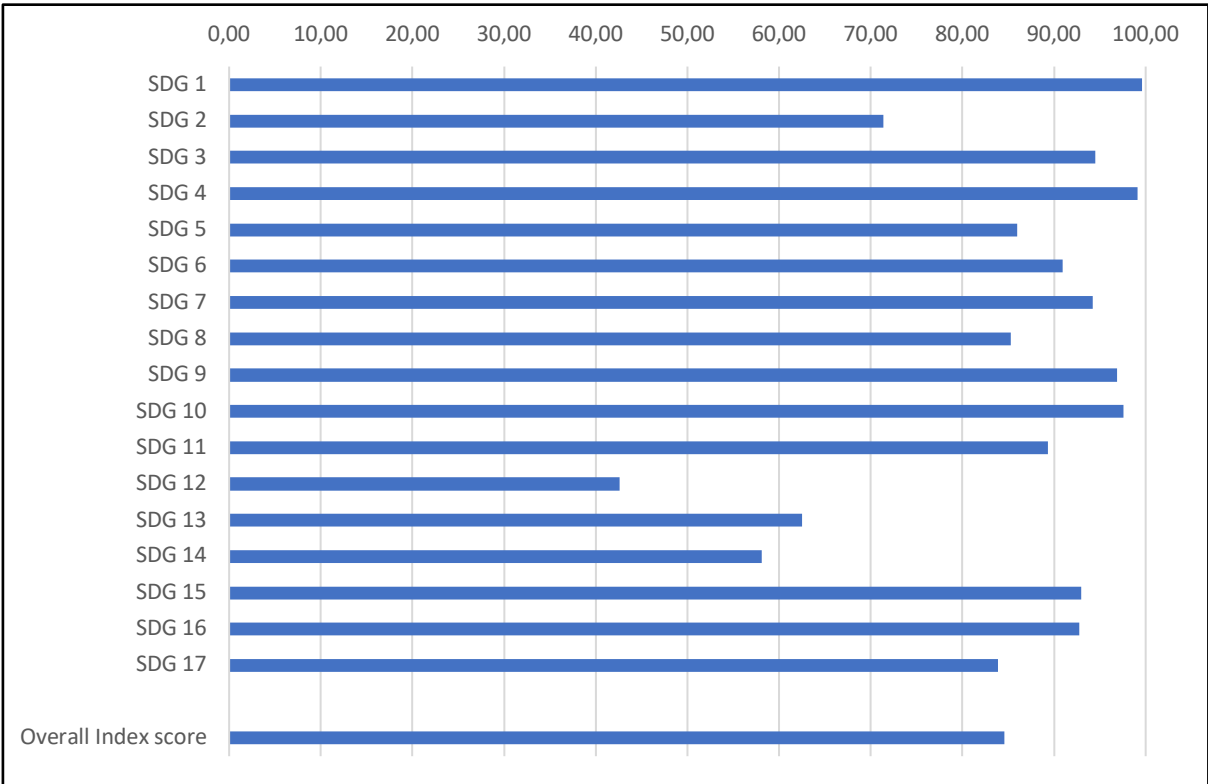
Different international, governmental and non-governmental initiatives have been launched for monitoring and assessing SDG performance on different levels and for different topics. The UN provides annual progress reports (see for instance United Nations 2019b) on selected SDGs and cross-cutting themes on the global level including larger (WHO) sub-regions.³ Eurostat is measuring progress on SDGs focusing on existing EU policies. The OECD has developed an approach to ‘measuring distance to the SDGs targets’ on a country level, and the Bertelsmann Foundation in co-operation with the UN Sustainability Development Solution Network (SDSN) publish the ‘SDG Index and Dashboard Report’ and rank the 193 countries according to their overall performance. In parallel, several initiatives exist for monitoring specific aspects of the overall sustainable development agenda with UN Intergovernmental Panel on Climate Change (IPCC) among the most well-known, essential and directly related to SDG 13 (climate action).

It is not possible here to list, compare and discuss the many different approaches to measure various aspects of ‘sustainable development’. All have their strengths and weaknesses. Neither is it possible to dive deeper into each of the 17 SDGs and the 169 related targets. Instead, we take the point of departure in the OECD ‘distance to SDG targets’ and the ‘SDG Index’ by the SDSN as reference points, since these are the ones that most governments and organisations relate to when national SDG progress reports are published. It is also the case for the Danish government.

The OECD ‘distance to SDG targets’ analysis from 2019 (OECD 2019) covers 101 of the 169 SDG targets and is based on 127 available indicators. According to the report, in 2019 Denmark achieved 20 out of the 169 2030 targets, and for several of the remaining targets, the ‘distance’ is relatively small, while for others the achievement seems to be far away from meeting the targets. If we take a closer look, it is a mixed picture depending on the selected indicators for each goal and how these indicators are weighted and what data is available. One example is SDG 3 on good health and wellbeing. Overall, Denmark has a high performance in most of the health-

related indicators but seems to be far away from meeting for instance the specific target related to rates of tobacco consumption (measuring target 3.a). While there are many indicators for SDG 3 on health and SDG 4 on education, there are only two indicators related to each of the goals 10, 11, 12 and 14. As pointed out by the OECD, inclusion of more indicators on these goals might shift the overall picture. This conclusion becomes clear if we instead take a look at the second well-established approach developed by the SDSN, where more indicators are included, see Figure 13.1:

Figure 13.1: Overall and Average Performance by SDG, Denmark 2020



Source: Sachs et al 2020; Data from Online database for Sustainable Development Report 2020

Since the SDSN published its first SDG index in 2015, Sweden, Denmark and Finland have topped the SDG global ranking positions. According to the Sustainable Development Report 2020 (Sachs et al. 2020), Denmark is ranked second (Sweden first) with an overall SDG index score of 84.6 (out of 100).⁴ Despite the relatively high overall SDG performance score, a closer look at the average performance by SDG reveals that since 2015 for some of the 17 goals Danish society seems to have moved in the wrong direction. According to the 2017 report (Sachs et al.

2017), Denmark had achieved the 2030 target for six out of the 17 goals (1, 3, 4, 9, 10 and 17) by 2017. In 2018 only two goals met the 2030 targets (1 and 10) (Sachs et al. 2018). In 2019 (Sachs et al. 2019) three goals (1, 10 and 16) and in 2020 the 2030 target was achieved for ‘only’ SDG 1 (no poverty) and SDG 10 (reduced inequalities) (Sachs et al. 2020). This means that different degrees of challenge still persist for the remaining 15 goals. For SDG 12 (responsible consumption and production), SDG 13 (climate action) and SDG 14 (life below water) the challenges are classified as major, for SDG 2 (zero hunger)⁵ and SDG 11 (sustainable cities and communities) challenges are classified as significant, and for the remaining 10 SDGs challenges continue to exist although with moderately improving trends for most of the SDGs compared to the 2019 report.

These performance rankings can be interpreted differently depending on the perspective. On the one hand, as the reporting indicates, in general and in relative terms (global and regional score) Denmark is performing well in relation to the SDGs, and the 2030 targets seem within reach. On the other hand, the reporting clearly indicates that important challenges remain and may even increase over time if no action is taken. From a sustainable transition perspective, it is worrying that Danish society faces significant challenges in meeting the 2030 targets relating to sustainable cities and communities (SDG 11), responsible consumption and production (SDG 12), climate action (SDG 13) and life below water (SDG 14). Reaching the 2030 targets for these SDGs will require major changes in existing consumption and production patterns, infrastructure and transport systems, energy production and the way farming and fishery are executed.

From the two examples on reporting, it is clear that it is a rather complex issue to provide an accurate picture of the SDG status for Danish society (or any other country). Different approaches have selected different indicators. The indicators used as background for the performance measures used by the UN SDSN (Figure 13.1) do not fully comply with the indicators suggested by the IAEG-SDGs. Data might not be available for all countries and when they are available, they may be outdated or not reliable. As an illustration, the 2020 SDG performance index for Denmark includes data from 2010 as the most recent up to 2020 depending on the specific indicator. As is generally the case when constructing a composite index, you often end up ‘adding apples and pears’ and the result depends on the relative weighting of the selected indicators. In the SDG performance index (Figure 13.1) all indicators are given the same weight when constructing the average performance per SDG. As many of

the 17 goals are mutually interdependent, this approach is problematic, and it might lead to wrong policy initiatives if a goal is singled out and removed from context. Another important issue is how activities in one country affect SDG targets internationally. One example on this is when Denmark is used as a showcase on ‘genuine green growth’ defined as a decoupling of greenhouse gas (GHG) emissions from economic growth (measured by GDP) (Stoknes and Rockström 2018). Increasing energy efficiency is part of the explanation, but a main explanatory factor is that coal is substituted by imported biofuel originating mainly from Baltic forests; similarly, when emissions from international shipping and air traffic are not included in the CO₂ emission calculations but at the same time the income generated from international shipping and air traffic are included as part of the GDP (Danish Council on Climate Change 2019).⁶

13.2.2 Specific supplementary Danish indicators and targets

As mentioned earlier, countries are encouraged to supplement the UN monitoring activities with more specific sub-goals and indicators relevant as signposts for country-specific actions. Denmark took part in the first (2017) voluntary national review initiated by the High-Level Political Forum (HLPF) on sustainable development, and in accordance with the 2030 Agenda, the Danish government formulated an Action Plan (2017) as part of the review in order to adapt the SDG targets to the Danish circumstances. The Action Plan took its point of departure in the OECD approach mentioned earlier and it was formulated around the 5 Ps (People, Planet, Prosperity, Peace and Partnerships). The liberal government formulated 37 related but more specific targets, each with one to two national indicators that are measurable and quantifiable (Danish Ministry of Finance 2017). At the election of the Danish parliament in 2019 climate came very high on the agenda, and the newly elected social democratic government has formulated a very ambitious climate act that received support from most parties in the parliament. The climate act aims at Denmark being ‘climate neutral’ in 2050, for emissions from GHGs to be reduced by 70% by 2030 compared to 1990, for an ‘indicative target’ to be set for 2025, and for the government to present a yearly progress report in order to document that the country is on track according to the targets.⁷ The 2019 climate act became a key argument for Denmark being able to jump from 15 to 5 on the Climate Change Performance Index (CCPI) (Burck et al. 2019). Since no country qualifies for positions 1–3, position 5 is relatively good compared to, for instance, the SDG Index Score on SDG 13 mentioned earlier. The CCPI has existed since 2005 as an independent monitoring tool for tracking countries’ climate protection performance. It is published yearly by Germanwatch, the New Climate Institute and the Climate

Action Network. The CCPI tool is an example on how sensitive the benchmarking is on the methodological approach and data sources. The CCPI assesses countries' performance in four categories with different weight: GHG emissions (40% of overall score), renewable energy (20% of overall score), energy use (20% of overall score) and climate policy (20% of overall score).

Following the need to develop relevant indicators, in 2019 the Danish 2030-Panel⁸ together with Statistics Denmark initiated an open SDG development project with the overall aim to establish supplementary Danish indicators on the status of the SDGs in Denmark. An important purpose of the indicator project (named 'Our Goals') was to raise the awareness and engagement of Danish citizens, institutions, organisations and companies for the 17 SDGs by calling for input and participation in public debates on how a status for the SDGs should be measured so it would become as relevant as possible in a Danish context. During autumn 2019 and spring 2020 the project organised public debates and workshops on each of the 17 SDGs in different parts of the country – and online after the COVID-19 outbreak – in order to involve as broad a group of people and interests as possible. Experts from universities, Statistics Denmark, NGOs and consultancies were 'called in' in order to prioritise among the many suggestions. After a round of public hearings on preliminary reports, the final baseline report was published in September 2020 (2030-Panel 2020) suggesting adding 197 supplementary indicators. Three types of examples may illustrate the importance of supplementing the over- all UN monitoring with country-specific indicators in order to mobilise for action.

The first example concerns SDG 1 (no poverty). According to UN monitoring, Denmark has achieved the 2030 target. However, this does not mean that *relative* poverty does not exist in Denmark and that no policy action is needed. By adding more nuanced supplementary indicators such as, for example, the number of homeless persons, number of persons on long term public support, share of families that suffer material deprivation (in relative terms) and distribution of wealth it becomes clear that SDG 1 is also relevant in a Danish context. The second example is SDG 12 (responsible consumption and production) where the Danish SDG performance indicates a long distance to the 2030 target. A key issue here is waste handling including waste reduction, and the result of the 'Our Goals' project is 13 supplementary indicators that in a more detailed form can monitor, for instance, recycling of material, waste of food, share of ecological food consumption as signposts for increasing awareness, policy interventions and actions from both private and public consumers and producers. The third and final example is related to SDG

9 (industry, innovation and infrastructure) where the supplementary indicator project ended up with 13 supplementary indicators. In the UN global monitoring, the SDG 9 indicators mainly focus on the general level of industrialisation, access to the internet and more narrow research and innovation indicators such as R&D expenditure (% of GDP), number of patents (per million population), scientific and technical journal articles (per 1000 population). In the Danish supplementary indicator project the focus for SDG 9 has been on selecting indicators that can monitor development of a green transition of not only industry (understood as manufacturing) but also of services and transport of goods and people. New knowledge and new technological solutions are necessary for realising a green transition and the supplementary indicators thus emphasise to what extent R&D activities, patents, etc. are targeting green innovation and sustainable transition. If the 197 supplementary performance indicators identified in the ‘Our Goals’ project are institutionalised as part of Danish society’s monitoring of the 17 SDGs, they will evidently improve the knowledge base for policy formulation and action towards sustainable development because these indicators are embedded and contextualised in local/national formal and informal institutions.

Despite the many problems related to these performance measures and benchmarking activities they may function as a wake-up call for policy makers and play an important role as a basis for policy action and assessment. It is definitely important to be able to find ways to measure to what extent progress is made on both a global and a local (national) scale even if these approaches do not give much information and help to actually formulate a policy strategy. In other words, a pragmatic approach is to see these performance measures as being a great deal better than nothing. It is also clear, that both the selection of relevant indicators and the availability of systematic and reliable data are in progress.

However, even with these improvements, a yearly status report on the performance measures only reflects a comparative static approach and does not in itself provide insights into how different learning and innovation capabilities driving the process of innovation depend and feed upon each other. In other words, it calls for what can be labelled a capability-based performance measure for sustainable development where learning and capability building are at the centre.

13.3 Towards a capability-based performance measure

In Section 13.2 the focus was on the national level and the SDG targets Denmark as a country has to accomplish by 2030. In that sense the SDG targets at the country level are to be seen as the overall targets for the Danish national innovation system. What then are the implications of applying an innovation system approach for policy-informing performance measures? In the current context we argue that the most prominent ‘feature’ is stressing the importance of linkages, interactions and learning processes. In a long-term sustainable development perspective, the capability to learn and innovate is, obviously, crucial and a discussion of innovation system performance has to reflect this. The learning and innovation capabilities of a national innovation system depend on many factors like R&D, education, vocational training, life-long learning opportunities, ICT facilities, availability of different types of capital, established modes of innovation, triple helix relations, the distribution of income, wealth and power, social cohesion and inclusion, and so on.

We are thus looking for a performance measure that can help indicate to what extent a national innovation system is enhancing its learning and innovation capability to transform towards a more sustainable society. Inspired by the ‘learning organisation’ and ‘learning culture’ approaches, we may define a learning society towards sustainable development as a society (Johnson and Lundvall 1994; Gregersen and Johnson 2005; Lundvall 2016):

- where learning, creativity and innovation fostering sustainable development are valued
- where investment in education and possibility for life-long learning towards a more sustainable production and consumption pattern are given high priority
- where time and other resources for learning and innovation targeting a transition towards a more sustainable society are available
- where interaction, co-operation and knowledge synergies between people, organisations and disciplines are stimulated
- where participation in the transition process is encouraged by giving learners voice and legitimacy in decision-making
- where learning opportunities are created and shared equitably among all citizens so ‘no one is left behind’
- where processes exist for a socio-economically sustainable distribution of the values created, including institutions and policies to compensate victims and handle conflicts related to sustainable structural changes and ‘creative destruction of knowledge’.

Performance indicators that reflect learning and innovation capability are necessary starting points for formulating and implementing policies for transition to sustainable development. Agreeing on the targets and monitoring the distance to the targets are crucial as mobilising for action but building the learning and innovation capabilities to implement the transition is a prerequisite.

Education and competence building in the broad sense is of course a basic ingredient. However, it is not only the general level of education or the extent of vocational training opportunities that are important, but also that creativity and innovation are stimulated through the education and training system and continue to be so in the way work is organised. Availability of supportive resources for learning and innovation influences not only the creation and diffusion of new knowledge in the innovation system but also which ideas are realised and implemented in product and process innovations. Interaction, collaboration and knowledge synergies between people, organisations and disciplines reflect key characteristics of the national innovation system and the importance of such linkages for the creation, diffusion and utilisation of new knowledge is well documented in the innovation literature. Finally, we state that fair and equal distribution of learning opportunities and costs and benefits of technological changes among its citizens is part of a sustainable development. Not only because social cohesion, innovativeness and wealth seem to be interrelated when seen in a long-term perspective, but also because equal learning opportunities and a social fair distribution of the costs and benefits of structural changes and ‘creative destruction of knowledge’ is relevant in its own right (Gregersen and Johnson 2005).

Recalling the introductory definition, performance measure should measure to what extent the innovation system delivers what is selected and defined as wanted and valued. This, of course, does not need to be the same for each national innovation system. In other words, targets should, in principle, be tailor-made as signposts for a sustainable transition process for the specific national innovation system or group of national innovation systems in question. For this we need an active approach trying to broaden the perspective in order to create a future demand for relevant indicators and data collection that emphasises performance as a dynamic capability-building process rather than as static single-point exercise. In that way, such performance measures can better support policy formulation and policy evaluation. This is a critical task for the innovation system community to take up as a constructive supplementary contribution to formulating policies towards sustainable transition.

We have argued that a national innovation system approach to analyse performance in relation to the 17 UN SDGs implies a rethinking of (or at least supplements) the prevailing SDG performance measures and indicators. It calls for a dynamic capability-based performance framework where learning and capability building is at the centre. It follows from that, that a broad definition of a national innovation system in combination with a broad definition of performance is needed where the interdependency between technical, organisational and institutional change is emphasised as a point of departure for formulating policies that stimulate a transition towards a more sustainable society. That well performing national innovation systems are crucial for adequate sustainability transitions becomes even more evident if we take into account new challenges related to changes in the total Earth system. In next section we briefly develop this argument.

13.4 A wider perspective on sustainable development

The very idea of sustainable development is increasingly challenged by a growing scientific and political awareness of a number of global challenges related to the onset of the Anthropocene era (Crutzen 2002; Gaffney and Steffen 2017).⁹

The biophysical system is becoming more complex, contingent and volatile and cannot be used as a fixed background for economic and social development in the same way as before. Humans are, so to speak, not any longer the sole actors on the scene. The Earth system with its many subsystems is changing and interfering with the development of human societies (Descola 2013; Steffen et al. 2015; Steffen et al. 2018). Or as Kotchen and Young (2007) express:

“Human and biophysical systems are coupled: human actions affect biophysical systems; biophysical forces affect human well-being, and humans respond in turn to these forces. (p. 149) ... Because the two sides of coupled systems are highly interactive, we cannot explain—much less predict—the behavior of these systems without treating both sides as endogenous.” (Kotchen and Young 2007, p. 150).

The onset of the Anthropocene implies that we need to implement transformative, structure-changing policies based on long-term thinking, often (a bit indefinitely) referred to as ‘sustainability transition’. There is a need for transformative capacity, i.e., an ability to mobilise

major innovation and investment activities to restructure society to meet the Anthropocene challenges. In such a transformative approach many kinds of innovation will be needed, from minor improvements of technologies already in use to transformative innovation restructuring production and consumption to keep society within planetary boundaries. It seems clear that meeting the challenges of the transition from the Holocene to the Anthropocene requires a new development path including strengthened learning and innovation capabilities as pointed out in Section 13.3. At the same time, because of the urgent time perspective, we need to cope with necessary immediate action in relation to climate change, loss of biodiversity, soil destruction, ocean acidification, etc. In sum, the Anthropocene challenge for a transition to sustainable development is to reconcile three different and partly conflicting imperatives: take immediate action, increase resilience, mitigation and adaptability, and implement transformative structural change in a world which appears more unstable and uncertain than ever before.

The SDGs do not explicitly take the Anthropocene challenge on board, but we may – as argued in this chapter – use the SDGs as pragmatic temporary approximations of the needs for transformative change in the transition from the Holocene to the Anthropocene. However, to some extent they do indirectly reflect an Anthropocene perspective: issues related to environmental sustainability play important roles in 12 out of the 17 goals. They are global and refer to ‘mankind’ and not only nations or classes. They refer to the need to transform our world and they integrate social, economic and environmental aspects. They imply major changes in existing structures and tendencies and they often refer to technical and institutional innovation as both necessary and effective instruments. At the same time, it is important to note that the 17 goals do not add up to an adequate definition of sustainable development in the Anthropocene. Interdependencies between the different goals, tipping elements in different environmental processes and some critical planetary boundaries are not receiving the attention they deserve from an Earth system perspective.

13.5 Conclusion

As demonstrated in this chapter, the Danish innovation system is performing relatively well in relation to the UN SDG performance indicators but still with major challenges before the 2030 targets are achieved – especially in relation to sustainable cities, consumption, production,

climate action and life below water. Despite the general weak spots of the prevailing SDG performance indicators, they play an important role in stressing that no country has yet managed to achieve all 17 SDG targets and that implementation will require considerable changes in ways of living, production and consumption in order to meet the 2030 targets on both a global and a national level. Such a transition calls for action from all parts of the innovation system including consumers, firms, knowledge institutions and policy makers.

Forming directions for sustainable development with such specific targets as the 17 SDGs, mobilising finance and other resources, coordinating policies across policy areas (e.g., energy, research and innovation, social, education, labour market, health) are necessary ingredients of a sustainable transition process. When the economy is viewed as a process of change rather than as an equilibrium system, innovation and learning become crucial and basic concepts. Furthermore, when the economy is looked upon as changing from within, constantly in the process of becoming something else, innovation and learning come forward as a means of change, as the process through which transformation is implemented. Technical innovation, organisational innovation, policy innovation and institutional innovation are the very processes, which create or detect novelty and introduce it into the economy and distribute it. This is why the prevailing UN SDG performance indicators need to be supplemented by a learning and capability perspective that emphasises closing the gap of competences, skills and experiences to implement a transition to more sustainable societies.

Successful implementation of the goals in the context of an increasingly insecure Earth system depends crucially on a number of institutional factors. SDG 17 considers implementation issues: it is stated that a massive redirection of public as well as private investment is needed to deliver significantly on the sustainable development goals. This is not only a responsibility for governments and international organisations like the UN. It requires partnerships between governments, the private sector and civil society on global, regional, national and local levels building on a shared vision, and shared goals that place people and the planet at the centre. The European Green Deal is one such important step. With the Green Deal the EU has agreed to take a series of initiatives to protect the environment and boost the green economy in order to reach the target to be climate neutral by 2050. Another example is the UN Science, Technology and Innovation Forum and the many UN partnership organisations targeting the SDGs. If a general and global popular movement could be built around the SDGs rather than around nationalistic

agendas different real existing capitalist systems might converge and serve as a platform for moving towards a more sustainable future.

Still, national agendas of technical and institutional change for greener solutions in different specific areas will be necessary parts of a global move towards navigating the Anthropocene in a way that respects the health of the biosphere and other planetary boundaries. Learning and innovation capabilities become vital. The need for strong national systems of innovation will increase as a result of the Anthropocene challenge to sustainable development.

Notes

1. SDG-1: no poverty; SDG-2: zero hunger; SDG-3: good health and wellbeing; SDG-4: quality education; SDG-5: gender equality; SDG-6: clean water and sanitation; SDG-7: affordable and clean energy; SDG-8: decent work and economic growth; SDG-9: industry, innovation and infrastructure; SDG-10: reduced inequality; SDG-11: sustainable cities and communities; SDG-12; responsible consumption and production; SDG-13: climate action; SDG-14: life below water; SDG-15: life on land; SDG-16: peace, justice and strong institutions; SDG-17: partnerships for the goals.
2. For detailed information on updates of the official UN SDG indicators, see <https://unstats.un.org/sdgs/indicators/indicators-list/>
3. The Sustainable Development Outlook 2020 edition (United Nations, Department of Economics and Social Affairs 2020) looks at how the COVID-19 pandemic may influence the SDG target progress in different ways. While the planet may have gained, targets related to people and prosperity are facing setbacks on a global scale.
4. In the 2019 report, Denmark ‘outperformed’ Sweden and scored 85.2 (out of 100), or in other words, average performance by some SDGs seems to have moved in the wrong direction from 2019 to 2020.
5. The full title of SDG 2 is ‘end hunger, achieve food security and improved nutrition and promote sustainable agriculture’. The prevalence of obesity defined as BMI > 30 is 19.7% among the Danish adult population.
6. An alternative approach is the so-called consumption-based emission accounting framework that aims at looking at the whole value chain (see for instance Lund et al. 2019).
7. However, formulation of concrete action plans is being delayed due to the COVID-19 crisis and it is yet to be seen if the COVID-19 pandemic will stimulate the necessary transition to more sustainable production and consumption patterns or the result is a setback not only in the short term.
8. The 2030-Panel is an advisory body established by the Danish parliament’s All Party Coalition for the Sustainable Development Goals in 2017. The panel has 23 members, including members from Danish industry organisations, labour organisations, regions, educational institutions, university experts.

9. The impacts of the human actions on biophysical systems are so comprehensive and deep that many observers now speak of human-dominated ecosystems and argue that we have entered a new planetary era best described as the Anthropocene (Kotchen and Young 2007).

References

2030-Panelet. 2020. *Gør Verdensmål til Vores Mål – 197 danske målepunkter for en mere bæredygtig verden* [in Danish], Vores Mål projektet. ('Our Goals' project).

Burck, J., Hagen, U., Höhne, N., Nasciento, L. and Bals, C. 2019. *Climate Change Performance Index. Results 2020*. (CCPI). Germanwatch, New Climate Institute & Climate Action Network. <http://www.climate-change-performance-index.org>

Crutzen, P.J. 2002. The anthropocene. *Journal de Physique IV*. France. 12 10 1–5. doi:10.1051/jp4:20020447

Danish Council on Climate Change [Klimarådet]. 2019. *Status for Danmarks klimamålsætninger og forpligtelser 2019*, Copenhagen: Klimarådet.

Danish Ministry of Finance. 2017. *Report for the Voluntary National Review. Denmark's Implementation of the 2030 Agenda for Sustainable Development*, Copenhagen: Danish Ministry of Finance.

Descola, P. 2013. *Beyond Nature and Culture*. Chicago: University of Chicago Press.

Dietz, R. and O'Neill, D., 2013. *Enough Is Enough: Building a Sustainable Economy in a World of Finite Resources*. San Francisco: Berret-Koehler Publishers.

Fagerberg J. 2018. Mobilizing innovation for sustainability transitions: A comment on transformative innovation policy. *Research Policy*, 47(9), 1568–1576. <https://doi.org/10.1016/j.respol.2018.08.012>

Fagerberg, J., Laestadius, S. and Martin, B. eds. 2015. *The Triple Challenge for Europe – Economic Development, Climate Change and Governance*. Oxford: Oxford University Press.
Gaffney, O. and Steffen, W. (2017). The Anthropocene equation. *The Anthropocene Review*, 4(1), 53–61.

Gregersen, B. and Johnson, B. 2005. *Performance of Innovation Systems: Towards a Capability Based Concept and Measurements*. Paper presented at The Third Globelics Conference,

Innovation Systems as framework for the promotion of economic growth, social cohesion and political development, Pretoria, South Africa, October 31–November 4.

Johnson, B. H. and Lundvall, B.-Å. 1994. The learning economy. *Journal of Industry Studies*, 1(2), 23–42.

Kotchen, M. J. and Young, O. R. 2007. Meeting the challenges of the anthropocene: Towards a science of coupled human-biophysical systems. *Global Environmental Change*, 17, 149–151.

Lund, J. F., Bjørn, A., Simonsen, M. B., Jacobsen, S. G., Blok, A. and Jensen, C. L. 2019. Outsourcing og omstilling: De danske drivhusgasudledninger genfortolket. *Samfundsøkonomen*, 4, 15–24.

Lundvall, B.-Å. 2016. *The Learning Economy and the Economics of Hope*. London: Anthem Press.

Markard J., Raven R., Truffer B. 2012. Sustainability transitions: An emerging field of research and its prospects. *Research Policy*, 41, 955–967.

OECD. 2019. *Measuring Distance to the SDG Targets 2019: An Assessment of Where OECD Countries Stand*. Paris: OECD Publishing. <https://doi.org/10.1787/a8caf3fa-en>.

Østergaard, C.R., Holm, J. R. and Park, E. 2021. Firms' contribution to the green transition of the Danish national system of innovation – changes in technological specialisation, skills and innovation. In Christensen, J. L., Gregersen, B., Holm, J. R. and Lorenz, E. eds. *Globalisation, New and Emerging Technologies and Sustainable Development – the Danish Innovation System in Transition*. Abingdon: Routledge.

Rockström, J. 2015. *Bounding the Planetary Future: Why We Need a Great Transition*. Great Transition Initiative (April 2015), <http://www.greattransition.org/publication/bounding-the-planetary-future-why-we-need-a-great-transition>.

Sachs, J., Schmidt-Traub, G., Kroll, C., Durand-Delacore, D. and Teksoz, K. 2017. *SDG Index and Dashboards Report 2017*. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G. and Fuller, G. 2018. *SDG Index and Dashboards Report 2018*. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G. and Fuller, G. 2019. *Sustainable Development Report 2019*. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G., Woelm, F. 2020. *The Sustainable Development Goals and COVID-19*. Sustainable Development Report 2020. Cambridge: Cambridge University Press.

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., de Vries, W., de Witt, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B. and Sörlin, S. 2015. Planetary boundaries: Guiding human development on a changing planet. *Science*, 347(6223), 736. doi:10.1126/science.

Steffen, W., Rockström, R., Richardson, K., Lenton, T. M., Folke, C., Liverman, D., Summerhayes, C. P., Barnosky, A. D., Cornell, S. E., Crucifix, M., Donges, J. F., Fetzer, I., Lade, S. J., Scheffer, M., Winkelmann, R. and Schellnhuber, H. J. 2018. Trajectories of the earth system in the anthropocene. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*, 115(33), 8252–8259, doi:10.1073/pnas.1810141115.

Stern, N., 2006. *The Economics of Climate Change: The Stern Review*. Report to UK Government 2006, available online https://webarchive.nationalarchives.gov.uk/20100407172811/http://www.http://hm-treasury.gov.uk/stern_review:report.htm

Stern N. 2015. Economic development, climate and values: Making policy. *Proceedings of the Royal Society London B*, 282, 20150820. <http://dx.doi.org/10.1098/rspb.2015.0820>

Stoknes, P. E. and Rockström, J. 2018. Redefining green growth within planetary boundaries. *Energy Research & Social Science*, 44, 41–49.

Teece, D. J., Pisano, G. and Shuen, A. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509–533.

United Nations. 1987. *Our Common Future* (Brundtland report), Report of the World Commission on Environment and Development.

United Nations. 2019a. *The Future is Now – Science for Achieving Sustainable Development*. Global Sustainable Development Report 2019.

United Nations. 2019b. *The Sustainable Development Goals Report 2019*. New York: United Nations.

United Nations, Department of Economic and Social Affairs. 2020. *Sustainable Development Outlook 2020 – Achieving SDGs in the Wake of COVID-19: Scenarios for Policymakers*, New York: United Nations, Department of Economic and Social Affairs.