Chapter 17

Systemic Policy Approaches for Cross-cutting Issues

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Executive summary

The physical, social, economic and health impacts of climate change, especially on the most vulnerable communities, require urgent adaptation approaches that are systemic, multidimensional and transformative *(established but incomplete).* Climate change adaptation is a complex process and needs to occur in all regions and sectors, at multiple temporal and geographical scales. It must consider the complex and interacting elements and feedback mechanisms of the human-environment system. {17.3.1}

Climate adaptation in coastal cities and small island developing states (SIDS) is generally categorized as 'protect', 'accommodate', 'retreat' *(established but incomplete)***.** Adaptation needs to deal with multiple slow and rapid onset hazards such as coastal erosion, sea level rise, tropical cyclones, floods or drought. Climate adaptation in coastal cities is still insufficient and may lead to increased risks in the future. Many low-lying SIDS are experiencing intensified flooding and coastal erosion and the area may become uninhabitable in the long term. {17.3.1}

A transformative approach for climate adaptation needs to deal with uncertainties and complexities arising from climate change impacts, address the drivers of risks and deal with the underlying factors of vulnerability, reduce inequality, address gender empowerment, and build resilience and adaptive capacity *(established but incomplete)*. {17.3.3}

The agrifood system is responsible for significant environmental externalities, including greenhouse gas emissions, and is highly inefficient on an energy basis (*well established*). Achieving the Sustainable Development Goals (SDGs) requires urgent action to reduce the agrifood system's environmental footprint and increase its overall efficiency. {17.4.1}

Agriculture is responsible for the majority of environmental consequences associated with food production (*well established*)**.** The two broad policy approaches for addressing this are: (1) incorporating the cost of negative environmental externalities into market prices via the 'polluter pays' principle; and (2) incentivizing farmers to minimize negative externalities or create positive externalities through payments for ecosystem services, which might be considered as the 'beneficiary pays' principle. {17.4.2}

Without a change in global dietary trends, food system emissions growth may mean that the Paris Agreement goal of limiting warming to well below 2°C is unlikely to be reached (*established but incomplete*). Most environmental policies in this area are oriented towards addressing the sustainability of food production, with less attention paid to waste and consumption. Several governments have introduced economic policy measures to encourage environmentally sensitive farming practices. There are nascent signs of sustainability criteria being incorporated into dietary guidelines to convince consumers to adjust their consumption patterns to optimize nutritional outcomes and to reduce the environmental burden of doing so. {17.4.3, 17.4.4}

Long-term planetary sustainability requires policy and technological interventions across energy systems to bring about choice of fuels, the way they are produced and consumed, and the way in which resources are affected systemically at every stage of the energy system (*established but incomplete*). {17.5.1, 17.5.2}

Mechanisms to address these challenges include carbon pricing (cap and trade systems, carbon taxes and other economic instruments such as fuel taxes and different subsidies to renewable energy), regulatory approaches (energy efficiency standards, command-and-control, mandatory decommissioning of old plants), information programmes (addressing behaviour, lifestyle and culture), and addressing administrative or political barriers (including through international cooperation) (*established but incomplete*). {17.5.3}

Decarbonizing supply and improving demand efficiency are two key policy elements that have been applied successfully (*well established*). Nevertheless, they need to be scaled up rapidly, together with the phasing in of new policies. {17.5.4}

The global economy currently operates predominantly in a linear mode whereby resources are extracted, converted through manufacturing to products and then disposed of (*well established*). {17.6.1}

The use of natural resources has grown rapidly over the last two decades and the global supply chains of resources have become more complex, resulting in growing environmental pressures and impacts (*well established*). {17.6.1}

A global shift is needed to a circular economy in which resource efficiency contributes to economic growth and human well-being, with reduced environmental pressures and impacts (*established but incomplete*). This would have substantial co-benefits for greenhouse gas abatement and waste and pollution minimization. {17.6.2}

A circular economy is a systems approach to industrial processes and economic activity that enables resource to maintain their highest value for as long as possible (*well established*). Key considerations in implementing a circular economy are reducing and rethinking resource use, and the pursuit of longevity, renewability, reusability, reparability, replaceability and upgradability for resources and products that are used.

Resource efficiency contributes to economic resilience by increasing the supply security of primary materials and closing of resource loops through remanufacturing and recycling, thereby reducing the pressures of resource exploitation, climate change, accumulation of toxic substances in ecosystems, and biodiversity loss (*well established*). {17.6.2}

Resource efficiency does not always happen spontaneously but requires well-designed policies that facilitate a change to sustainable systems of production and consumption and sustainable infrastructure (*established but incomplete*). {17.6.4}

Systems, product and service design that reduce demand and increase efficiency in resource use are key to bringing about the circular economy (*inconclusive*). Cross-sector and cross-disciplinary collaboration that empowers consumers as citizens is also key. {17.6.4}

Resource efficiency, greenhouse gas abatement and waste minimization policies, implemented together, will enable the decoupling of economic development and human well-being from global environmental degradation and resource exploitation (*inconclusive*). {17.6.4}

17.1 Cross-cutting policy issues and systemic change

The 2030 Agenda for Sustainable Development affirms the determination of governments to "take the bold and transformative steps which are urgently needed to shift the world on to a sustainable and resilient path." Achieving this transformation requires urgent and dramatic change in cross-cutting sustainable development policy areas which have closely intertwined social, economic and environmental dimensions.

Chapter 4 of this report identifies 12 cross-cutting issues of immediate concern for policymakers: health, environmental disasters, gender, education, urbanization, climate change, polar regions and mountains, chemicals, waste and wastewater, resource use, energy, and the food system. Because of their link to key economic, social and environmental systems, four of these 12 cross-cutting issues – climate change, food, energy and resource use – are selected for further analysis here.

This chapter evaluates the capacity of environmental policies to achieve transformational change in addressing cross-cutting global sustainable development challenges. To this end, the chapter addresses the major challenges of adapting socioeconomic systems to climate change, creating a sustainable agricultural and food production system, decarbonizing energy systems, and creating a circular economy. The world's pressing environmental challenges are the consequence of deeply rooted socioeconomic systems that reach across multiple policy areas. If global human needs are to be met within planetary boundaries there must be a transformation in the operation of these systems to reduce biophysical resource use and achieve just social outcomes (Raworth 2012; O'Neill *et al.* 2018). Systemic transformation will be very challenging for some communities but will provide a range of benefits and opportunities. Some of these opportunities can be realized in the short term, others over a longer period. In order to achieve a transformation which attracts widespread support, the opportunities and challenges will need clear communication, the expectations of affected groups and sectors will need to be considered, while those who suffer dislocation or negative distributional impacts from change will need to be compensated, retooled and reskilled.

17.1.1 A safe operating space

Transforming global systems towards a sustainable and resilient path is a major challenge because of the legacy of past policies, knowledge systems and cultural norms (Economic and Social Commission for Asia and the Pacific [ESCAP], Asian Development Bank [ADB] and United Nations Development Programme [UNDP] 2018) and because of the inherent complexity in policy arenas, involving many issue areas and actors. Climate change, for instance, has been described as a "diabolical policy problem" because its solution requires high levels of cooperation among governments and the implementation of policy measures across many economic sectors (Garnaut 2008).

In the Anthropocene, cross-cutting policy challenges involve a tightly coupled interdependency between the biophysical and socioeconomic elements of the Earth system (Liu *et al.* 2007; Biermann 2014; Young 2017). The central challenge for environmental policy in this new era is meeting human needs in a way that does not overstep planetary boundaries, and stay within a safe operating space for humanity (Rockström *et al.* 2009). For this objective to be reached there must be a radical reduction in biophysical resource use and a transformation in physical and social provisioning systems which connect resource use to just social processes and outcomes (Raworth 2012; O'Neill *et al.* 2018).

In pursuing transformation, it is vital that policymaking is strategic, coordinated and directed to the achievement of a clear vision. Environmental policies that address only one aspect of a systemic, cross-cutting, sustainable development challenge are unlikely to achieve the change necessary to shift the earth's socio-ecological systems to a pathway towards sustainability. For example, an isolated policy for reducing greenhouse gas emissions for one product may provide an economic incentive for production to shift to another, unregulated, product with the result that there is no net or economy-wide emissions reduction (Yang *et al.* 2012; van den Bergh *et al.* 2015). This is why in some contexts general regulation is preferable to technology-specific policies that 'pick winners'. Cross-cutting environmental issues must therefore be approached holistically, with policy interventions implemented with the objective of transforming the relevant system as a whole, including shifting collective behaviour and changing unsustainable social practices and norms.

However, setting the necessary and ambitious goal of transforming socio-economic or socio-technical systems does not always mean that the environmental policies directed to achieve this goal must be all-encompassing. An effective strategy for transformation that pursues a clear and overarching vision can be given operational effect through environmental policies applicable at macro, medium and micro scales. In some policy contexts, small-scale targeted interventions that can create innovation will be more effective than expansive policies. From this perspective, promotion of specific technological or social innovation can in some circumstances be justified. There is evidence that transformation of some socio-ecological systems can begin from change made within niches that can lead to technical and other innovations that result in more sustainable patterns of resource use (Doyon 2018). While small changes to one system may lead rapidly to a tipping point and a transformation of the system, other systems are more entrenched and robust and not easily shifted to a sustainable mode. Breaking through this path dependency requires a suite of policies and approaches at multiple scales.

17.2 Key actors, policies and governance approaches

Globalization has resulted in the emergence of complex global socio-ecological systems that do not operate in a predictable way and can give rise to nonlinear change. This means that policymaking and implementation occurs under conditions of uncertainty and there is an increasing premium on environmental governance that can respond in an agile way to rapid and unanticipated change (Young 2017). In this context, governments retain a central role in achieving successful transformation of socioeconomic systems. Governments continue to have the capacity to adopt a collection of policies from command-and-control regulations through to market-based measures in response to environmental problems. There are many examples where decisive government intervention has delivered major environmental benefit and transformed existing systems (e.g. the phase out of ozone-depleting substances, and the control of oil pollution from ships in the marine environment).

However, sometimes traditional governance approaches have their limits, including when what is needed is transformative change. Socio-ecological systems are increasingly complex in the variety of their components and their interactions so that it is not always possible to predict in advance what impact policy measures may have (Young 2017). Therefore, in addressing cross-cutting challenges, requiring whole-of-system change, there needs to be a willingness on the part of governments to engage in a reflective and experimental process of 'learning by doing', including regulatory experiments to test the feasibility of various approaches (e.g. Ostrom *et al.* 2007; Dryzek 2014).

This process of 'transformative learning' (ESCAP, ADB and UNDP 2018) can promote innovation by enabling experimentation through:

i. creating and highlighting opportunities for communities to embrace new and alternative visions for serving human needs in a sustainable way;
ii. enabling the participation of new actors that can provide more sustainable resources and services; and
iii. transparently phasing out existing unsustainable structures.

Government has an important role in this process but there is a broader dynamic at play in which it is possible to achieve 'governance without government' (Ostrom 1990). Key to this process is social mobilization around shared values and a vision for just and sustainable systems.

17.2.1 Evaluating the effectiveness of policies for cross-cutting issues

On the basis of our continually improving understanding of environmental policymaking, it is possible to evaluate the effectiveness of environmental policies that address cross-cutting issues and their systemic drivers. This not only refers to their immediate or short-term performance in achieving their specific targets, but also to their potential to engender systemic transformation. There are two key criteria in this respect, namely the objective of the policy and the outcome of the transformation.

This chapter focuses on four cross-cutting global-scale sustainable development challenges and asks:

i. What are the most urgent changes required in the system?
ii. Which elements of the system do policies seek to address?
iii. What has been done to date and how effective have these measures been?
iv. What is the transformative potential of the policy approaches discussed?

In undertaking this assessment, four sustainability challenges are examined through the lens of specific case studies which illustrate policy responses in a range of different settings and highlight challenges and opportunities for policy design and implementation. This chapter also provides broader insights on the effectiveness of cross-cutting environmental policies by examining policy-sensitive indicators.

17.3 Adapting socioeconomic systems to be more resilient to climate change

Climate change adaptation is a critical issue for coastal cities and Small Island Developing States (SIDS), as these are places where exposure to climate change impacts is increasing dramatically because of sea level rise. This is combined with dense populations and infrastructure along the coasts, rapid and often unplanned urbanization of low-lying areas, loss of ecosystems and environmental degradation, unsustainable management of natural resources, and lack of existing adaptive capacities.

Climate change adaptation needs to address both natural and human systems. Natural systems such as beaches, wetlands and coral reefs need to be protected by maintaining coastal ecosystems and processes and preventing erosion and flooding. Human systems – including settlements, industry, infrastructure, agriculture, fisheries, tourism, recreation and health – must be strengthened to become more climate-resilient. Adaptation strategies have recognized the special importance of safeguarding the most vulnerable groups, including Indigenous Peoples, women, children, those living with disabilities, and economically disadvantaged communities.

17.3.1 What are the most urgent changes required in the system?

The impacts of climate change differ across geographical locations, sectors and social groups. It particularly affects the lives, livelihoods and psychological well-being of the poor, vulnerable communities and people affected by disasters (Davis 2015; Dankelman 2016). Primary impacts include health risks related to temperature stress and extreme events leading to increased mortality and injury, internal and cross-border displacement, and infrastructure and economic loss and damages (Watts *et al.* 2015; Grimmins *et al.* 2016; Internal Displacement Monitoring Centre [IDMC] and Norwegian Refugee Council 2017). The secondary health impacts are mediated via the environment, including increased risk of climate-sensitive disease, which can be vector-, water- or food-borne. Tertiary impacts are socially mediated and include migration and conflicts (Watts *et al.* 2015). This requires adaptive responses to protect, preserve and promote human health and well-being.

What elements of the system do the policies seek to address?
Adaptation to sea level rise in coastal cities and SIDS seeks to address vulnerability to the following climate change impacts: coastal erosion, sea level rise, floods, and extreme events. They are generally categorized as 'protect', 'accommodate' or 'retreat':

- **Protection** of people and property by building higher seawalls, improving land-use management, developing new building codes to raise dwellings and infrastructure and reducing coastal erosion;
- **Accommodation** by changing the existing practices to make them more resilient to sea level rise, improving

infrastructure to increase absorption capacity of water bodies and wetlands, regulating water flow, introducing insurance; and

- **Retreat** by abandoning high-risk areas and relocating people away from the hazard.

Climate adaptation in coastal cities is still insufficient and may lead to increased risks in the future. Protecting existing populations and infrastructure has often led to even more development in high-risk areas, resulting in the accumulation of risk (Hallegatte *et al*. 2013). Climate adaptation programmes have not effectively dealt with multiple slow and rapid onset hazards, such as floods, droughts, tropical cyclones and sea level rise. They are often undertaken through sectoral programmes in, for example, agriculture, health and disaster management, rather than addressing the underlying causes of vulnerability. This has implications for human rights since persistent inequalities in terms of access to assets, opportunities, voice and participation, or discrimination mean poor and vulnerable communities lack adaptive capacity and are disproportionately exposed, and highly sensitive, to climatic hazards (United Nations 2016).

Some low-lying SIDS have experienced increasing flooding and significant coastal erosion and are expected to eventually become uninhabitable. Affected populations will be displaced and will need to migrate to other places or countries, with accompanying implications for their health and well-being (Schwerdtle, Bowen and McMichael 2018). Policy responses need to strengthen health systems to make them both climate-resilient and migrant-inclusive (Schwerdtle, Bowen and McMichael 2018). They also have to be integrated with other policy areas, such as border and labour market policies, and social and human rights protection.

17.3.2 What has been done to date and how effective have these measures been?

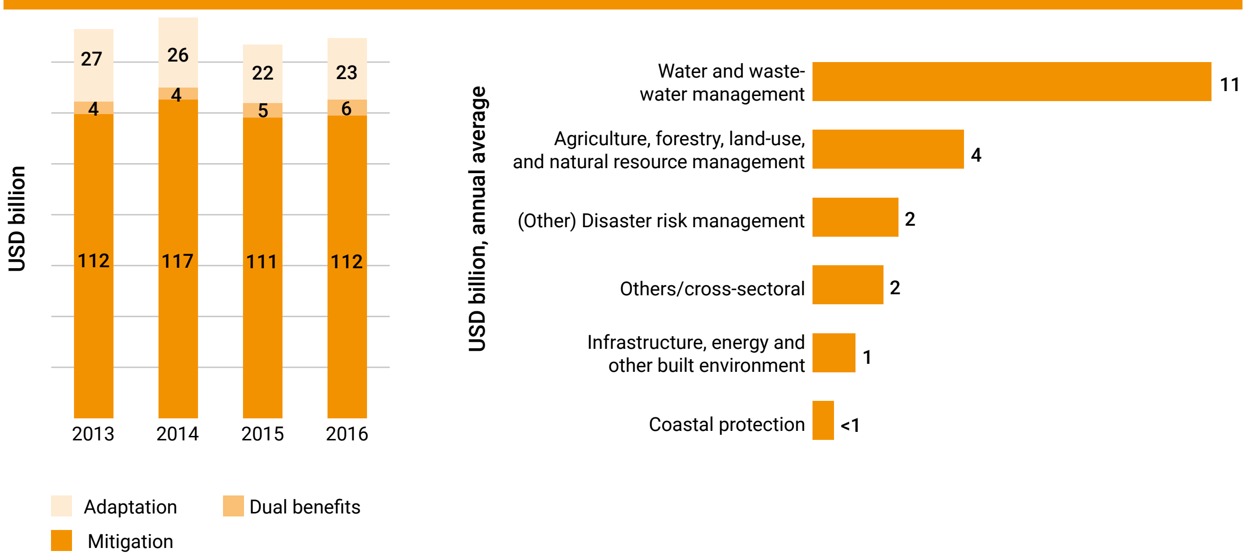
SDG 13 recognizes climate change as a critical issue and calls for urgent actions through strengthening resilience and adaptive capacity, mainstreaming it into policies and planning, education and capacity-building. The 2015 Paris Agreement on climate change seeks to strengthen the capacity of countries to deal with the impacts of climate change and support action by developing nations and the most vulnerable countries. Support provided through strategies and mechanisms under the Paris Agreement include climate adaptation funds, technology transfer and climate insurance.

Global climate finance is US$410 billion on average annually (Buchner *et al*. 2017). However, 93 per cent of this is spent on mitigation, while less than 5 per cent (US$22 billion) is spent on adaptation (Buchner *et al*. 2017). Looking deeper into adaptation finance, less than US$4 billion is spent on coastal protection, infrastructure and disaster risk management (Buchner *et al*. 2017). These are areas in greatest need if adaptation is to be strengthened in coastal cities and SIDS **(Figure 17.1)**.

The United Nations Office for Disaster Risk Reduction (UNISDR), through the Sendai Framework for Disaster Risk Reduction (UNISDR 2015), recognizes the need for better integration of disaster risk reduction (DRR) and adaptation, since climate change increases the severity, intensity and frequency of disasters. Strengthened and more coherent actions towards the 2030 Agenda, the Paris Agreement and the Sendai Framework are being developed (UNISDR 2017). The focus in this area has moved from emergency management and response to reducing disaster risks and mainstreaming it into development.

Deaths from disasters have been dramatically reduced through early warning systems and better disaster preparedness and planning, while the current challenge is that the number of people affected and economic loss continues to increase (UNISDR 2017). The New Urban Agenda (United Nations Human Settlements Programme [UN-Habitat] 2016), coordinated by the United Nations Human Settlements Programme, is a global framework on sustainable urbanization to "make cities and human settlements inclusive, safe, resilient,

Figure 17.1: Climate finance on adaptation



Source: Buchner *et al*. 2017.

and sustainable". It is clearly recognized that cities, especially those on coastlines, are where some of the most vulnerable places and infrastructure are located (World Bank 2013). Within the framework of the Global Action Programme (GAP) on Education for Sustainable Development, United Nations Educational, Scientific and Cultural Organization (UNESCO) implements Climate Change Education (CCE) alongside Education for Sustainable Development (ESD) programmes (UNESCO 2014). CCE includes, among other issues, the science of climate change, social and human aspects, policy responses and sustainable lifestyles (UNESCO 2010). To ensure effectiveness of this policy, research shows that educational interventions are most successful when they focus on local, tangible and actionable aspects of sustainable development and climate change, especially those that can be addressed by individual behaviour (Anderson 2013).

The Pacific Adaptation to Climate Change (PACC) Programme is the first major climate change adaptation initiative in the Pacific region and is a partnership between several key regional and national agencies and communities in 14 Pacific island countries. It is coordinated by the Secretariat of the Pacific Regional Environment Programme (SPREP). An assessment of this programme calls for a more integrated approach to climate change, disasters and climate mitigation, and better management of information and data (Hay 2009). Policies related to climate-related migration are only just emerging. There are policy frameworks that have sought to integrate migration with border protection, livelihoods and social and human rights protection such as those developed by the Asian Development Bank (ADB 2012) and the Protection Agenda of the Nansen Initiative (2015), but implementation remains rare at the local level.

17.3.3 What is the transformative potential of the policy approaches discussed?

The policy approaches and case study presented **(Box 17.1)** reinforce the need for better identification of governance for adaptation to address the complexities of the processes leading to and resulting from climate change impacts, and the underlying factors of vulnerability, and to build resilience and adaptive capacity. Governance of adaptation refers to the pattern that emerges from the processes of governing the social, political and administrative actors involved (Huitema *et al.* 2016). Successful adaptation requires consideration of effectiveness, efficiency, equity and legitimacy to ensure the sustainability of development pathways into an uncertain future (Adger, Arnell and Tompkins 2005).

A transformative approach towards adaptation to climate change is increasingly proposed as an approach to deal with the impacts of climate change and can potentially offer changes in the way current adaptation is governed and implemented towards being resilient and sustainable. It is an approach that has the potential to mediate complexity, uncertainty and rapid change. Its identified characteristics include adaptive management, particularly in allowing learning and self-organization; addressing scale to increase a governance 'fit' between social and ecological aspects; and a polycentric governance system allowing redundancy and diversity through participation and collaboration (Brunner *et al.* 2005; Folke 2006; Brunner and Lynch 2010; Djalante, Holley and Thomalla. 2011; Chaffin, Gosnell and Cosens 2014). The transformative potential is reflected through innovation, experimentation, vision and space for new actors. Learning allows for experimentation to take place, visions to be generated and innovations to flourish (Taylor 2017). Actions are taken based on the best available knowledge and allowing for learning from mistakes and innovation to take place. Climate change education also contributes to capacity-building for decision makers and empowers people to implement their own adaptation strategies – for example, by equipping them to understand complexity, perceive risks and take into account indigenous knowledge (Nakashima *et al.* 2012; Blum *et al.* 2013; Monroe *et al.* 2017; UNESCO 2017; UNESCO 2018). Overall, the learning by different stakeholders increases transformation capacity.

Box 17.1: Case study: 'Living With Floods' programme in Viet Nam

This case study provides an example of policy approaches towards achieving effective adaptation, despite vast complexities in setting targets for achieving policy effectiveness (i.e. social equity/human rights, community participation, economic variability, differing capacities, and multilevel policy fragmentation). The Vietnamese approach could be considered as transformative because flood risk management policy changed from control to 'living with floods'. However, the effectiveness of the approach is limited in the face of increasing hazard risks in the Mekong Delta.

The 'Living with Floods' programme is part of the National Strategy for Natural Disaster Prevention, Response and Mitigation to 2020. It aims to accommodate rather than control floods through the use of semi-dykes that allow occasional and controlled floods, which in turn lead to better soil management. Residential clusters are protected from flooding by a full- and semi-dyke system. There are permanent residences and access to basic public services and facilities, such as schools and health clinics (Central Committee for Flood and Storm Control [CCFSC] 2012). Up to 150,000 households are involved with the programme. These households are chosen directly by local authorities in the Mekong Delta. Poor households are eligible for a long-term, low-interest government loan to fund the acquisition of their new home, while wealthier households can purchase housing plots directly. A weakness of the process is a lack of transparency with regard to the selection of households and the allocation of funds. The sustainability of the funding from the national government is uncertain. There is no community participation or consultation in the selection of relocation sites (Chun 2015).

Overall, though the programme moved communities out of harm's way, it has resulted in an increase in the economic vulnerability of most households due to loss of livelihoods. Economic and solidarity networks have been dislocated in the process, and most households report decreased income, as well as difficulties in repaying their debts (Chun 2015; Entzinger and Scholten 2016). Such detrimental outcomes are largely the result of lack of integration of environmental with other policy objectives, such as long-term economic sustainability. As a result, though the programme contains many positive aspects and intentions, it has led to decreased community resilience.

17.3.4 Indicators

Indicators play a critical role in the monitoring and evaluation of climate change adaptation. The indicators for SDG 13, 'Climate action', do not provide the most direct measurement of adaptation effectiveness. The level to which the CCA action contributes to achieving SDG 5 (achieving gender equality and empowering women and girls) and SDG 10 (reducing inequality within and among countries) are also important indicators of success.

Scientific frameworks for measuring vulnerability, resilience and adaptive capacities along with indicators have been developed (e.g. Cutter, Boruff and Shirley 2003; Turner *et al.* 2003; Wisner *et al.* 2004; Hinkel *et al.* 2012; Taylor 2017). Examples of indicators to measure effective adaptation efforts for coastal cities can include identifying the amount of land area known to have (in)sufficient infrastructure, reducing the number of residents living in floodplains or low-elevation coastal zones, or developing a network of communication channels in times of crisis or disaster. For SIDS, indicators for adaptation include measures to respond to decreases in available fresh water (drought-resistant vegetation, water-saving devices, establishing buffer zones to protect catchment areas), prevention and removal of maladaptive practices (amend policies that lead to destruction of mangroves, laws preventing recycling of water, or allowing building in vulnerable areas), and address impacts of climate change on biodiversity and land degradation (land-use models for efficient farming, sustainable fishing practices, raising community awareness) (United Nations 2015).

Some considerations for achieving more transformational change – and ensuring effective adaptation measures – include consideration of scale (using a landscape- or basin-scale approach, and distinguishing between short-, medium- and long-term strategies), community participation, novel approaches to adaptation (e.g. the use of crop insurance in developing countries, building market resilience to climate change), and those that transform places or shift locations (artificial islands combined with relocation, and new institutions and funding mechanisms for reduced vulnerability) (Kates, Travis and Wilbanks 2012). Vulnerability and capacity assessments (VCA) together with climate risk screening and assessment are necessary to ensure that future development programmes consider impacts of climate change – see, for example, the International Federation of Red Cross and Red Crescent Societies VCA (International Federation of Red Cross and Red Crescent Societies n.d.), and Climate and the Disaster Risk Screening tool from the World Bank (World Bank 2018), or UNDP Report on stocktake of climate risks screening tool (Olhoff and Schaer 2010).

17.4 Creating a sustainable agrifood system

One of the best illustrations of the need to reduce uncertainties in the face of climate change is found in the agrifood system. The following section looks at some of the possibilities for transformation in this sector.

17.4.1 What are the most urgent changes required in the system?

The agrifood system is responsible for significant environmental impacts including greenhouse gas emissions, habitat destruction and biodiversity loss, and pollution of air and water resources. These environmental costs are compounded by the inefficiency of the agrifood system. According to one study, 62 per cent of the energy (in terms of kcal) harvested as crops and other biomass, is lost or wasted after accounting for losses from food waste, trophic losses from livestock, and human overconsumption (Alexander *et al.* 2017). Achieving the SDGs requires urgent action to reduce the system's environmental footprint and increase its overall efficiency and resilience. A whole-system approach is needed, including action to intensify agriculture sustainably, reduce food losses and greenhouse gas emissions along supply chains, and tackle wasteful consumption patterns including high consumer food waste and overconsumption of animal products.

Policies that shape the agrifood system can be broadly categorized in terms of production, processing and distribution, and consumption. Agricultural policies are typically focused on supporting farmers rather than on providing incentives for improved environmental outcomes. Moreover, reforming subsidy regimes often presents governments with significant political challenges. To the extent that they encourage production without accounting for environmental impacts, many agricultural policies exacerbate environmental problems (e.g. subsidies for fertilizer, water or energy use). Few governments have developed strategies for reducing greenhouse gas emissions from the agriculture and land-use sector (with the notable exception of forests); to date, no national government has fully included agriculture in a carbon pricing scheme.

Trade policies for agricultural commodities typically avoid explicit environmental criteria in order not to contravene World Trade Organization (WTO) rules that prevent governments from distinguishing between 'like' products, while regulations are concerned primarily with human health. Incentives to reduce food waste and losses have been eroded by low and declining real food prices (Benton and Bailey in press) and, despite increasing government intervention to shape consumption patterns for public health reasons (e.g. to reduce consumption of sugar, salt and trans fats), there is little policymaking that encourages sustainable diets (Garnet *et al.* 2015).

In sum, transforming the agrifood system to achieve the SDGs requires that the environmental footprint of agriculture is dramatically reduced, food losses and waste are drastically curtailed, and populations adopt healthier and more sustainable diets. This in turn requires a shift in policymaking to:

i. incentivize farmers to reduce negative environmental externalities, including greenhouse gas emissions, and create positive externalities, such as enhanced biodiversity or other ecosystem services;
ii. tackle food losses and waste along the entire value chain; **(Box 17.2)** and
iii. encourage the adoption of healthy and sustainable dietary patterns.

17.4.2 Which elements of the system do policies seek to address?

The polluter pays principle

Environmental impacts are a common symptom of agricultural policies that support farmers to maximize food production. Policy reforms designed to eliminate these impacts can take different forms, but essentially seek to ensure that the 'polluter pays'. Examples include taxes on fertilizer and pesticide use (rather than subsidies), water pricing schemes and regulations requiring farmers to build and maintain storage infrastructure for animal slurry.

While there is considerable national experience in applying the polluter pays principle to carbon emissions in the energy sector via emissions trading schemes and carbon taxes, agriculture remains excluded from such initiatives. Monitoring, reporting and verification of emissions in agriculture is considerably more complex and costly than for energy, because greenhouse gas emissions occur at the landscape scale according to farming practices and agroecological context. Nevertheless, this does not necessarily present an insurmountable barrier. For example, in New Zealand, the agricultural sector reports its greenhouse gas emissions without being part of the national emissions trading scheme, indicating that it is possible to quantify and account for emissions from agriculture.

The beneficiary pays principle: payments for ecosystem services (PES)

Several governments have introduced economic policy measures to encourage environmentally sensitive farming practices. The basic intention is to incentivize and reward those agricultural producers who take steps to minimize their environmental impacts or to deliver non-productive outputs (often termed 'payment for ecosystem services' [PES]), and to disincentivize and penalize those who do not (Meyer *et al.* 2014; Tanentzap *et al.* 2015). One such example is agricultural producers' participation in carbon markets by selling offset credits generated by specific projects to reduce emissions (Garnett 2012). In this case, rather than being penalized for emitting greenhouse gases as regulated entities under a carbon pricing scheme, farmers are paid for avoiding emissions.

The market for PES is growing and is now estimated at between US$36 billion and US$42 billion a year, including payments from non-governmental and private buyers. The largest areas include payments for watershed management and biodiversity, with the vast majority of payments for emissions reductions coming from forest projects (Salzman *et al.* 2018). Although by no means a negligible sum, these transfers are modest compared with conventional agricultural support, which totalled just under US$230 billion in 2017 in Organisation for Economic Co-operation and Development (OECD) countries and a similar amount in China (US$204 billion) (Organisation for Economic Co-operation and Development [OECD] 2018).

Consumer education

Consumer education, based on the concept of education for sustainable development, can enable consumers to understand how their individual dietary choices and habits influence social, economic and environmental development, to envision sustainable dietary choices and habits, and to adopt them (Fischer and Barth 2014; UNESCO 2017). For example, education can make meat consumers more aware of their own unsustainable consumption (Spannring and Grušovnik 2018).

Dietary guidelines

Governments typically use national guidelines to inform populations about good nutrition and healthy eating. In recent years, a small number of governments have begun to include environmental considerations in the guidelines they publish (see below for a discussion). National guidelines are unlikely to lead to widespread changes in eating habits on their own, but they can provide a basis for subsequent policymaking, and as such may constitute an important first step on the path to more concerted policy action (Bailey and Harper 2015, Garnet *et al.* 2015).

Labelling and certification

Schemes that provide consumers with assurance that a particular food meets certain environmental criteria have become increasingly common in developed country markets. These initiatives tend to be multi-stakeholder in their origins rather than policy led, often emerging from cooperation between the private sector and civil society; however, where sufficiently robust they can provide a basis for subsequent policymaking.

Public procurement

In many countries, public procurement of food can represent an appreciable share of market demand, hence public procurement policies in this area require suppliers to meet certain environmental standards and have the potential to drive wider change in the food system.

Consumption taxes

The costs of negative environmental impacts can also be incorporated at the point of consumption. To date, consumption taxes have been used to address health externalities associated with overconsumption of foodstuffs such as sugar. However, applying an emissions tax on foods at the point of consumption may be preferable to pricing emissions at the point of production. Although the latter approach may more accurately internalize the impact, consumption taxes may still be a better option because:

i. the costs of monitoring emissions in agriculture are high;
ii. the mitigation opportunities beyond reducing output of emissions-intensive foods are limited; and
iii. the opportunities for consumers to switch from foods of high emissions intensity to low emissions intensity are high (Wirsenius, Hedenus and Mohlin 2011).

Nonetheless, consumption taxes do not need to be blunt instruments with blanket rates applied indiscriminately across a product category. Differentiation between production and supply practices within a product category (e.g. by using disaggregated life cycle analyses) would allow for more nuanced reflection of externalities and incentivize the adoption of more sustainable practices, as well as consumer-switching to more sustainable products, within – as well as across – food categories. The transformative potential of consumption taxes could be high. It is estimated that worldwide emissions taxes on foods could save around 1 gigaton of CO_2 equivalent per year in 2020 and result in net health benefits at the global level due to reduced consumption of meat, although this would entail distributional impacts that governments would need to manage with compensating policies (Springmann *et al.* 2016). No government has yet imposed an emissions tax on food, although some have implemented consumption taxes on certain foods for public health reasons.

17.4.3 What has been done to date and how effective have these measures been?

Production: economic incentives for ecosystem services

Payments for ecosystem services may pertain to additional conservation or sustainability practices to which agricultural producers commit voluntarily, or they may offer financial compensation to farmers whose income or production capacity is limited by the requirements of existing regulation (often referred to as 'cross-compliance') (Meyer *et al*. 2014).

In the European Union (EU), both approaches have been used under the Common Agricultural Policy (CAP). Agri-environment measures (AEMs) under Pillar II of the CAP are area-based mechanisms that occupy a middle ground between entirely voluntary schemes and direct compensation for cross-compliance. Funded jointly by the CAP and national authorities, AEMs are intended to encourage farmers to improve soil quality, use water resources more efficiently, reduce polluting inputs, and increase agricultural biodiversity. The majority of AEMs are action-based, compensating farmers for the activities they undertake, but more recently results-based AEMs have been introduced, with increased conditions and payments dependent on achieving desired environmental outcomes. These AEMs are less prescriptive with regard to management practices, are more cost-effective, and can encourage innovation (Illes *et al.* 2017). Generally, PES programmes applied nationally or internationally will be better able to maximize these benefits if they are flexible enough to be tailored to the unique conditions of local institutional and environmental contexts (de Blas *et al.* 2017).

As part of the CAP 2014-2020 Reform, the EU introduced a new form of direct payment support in 2015. The 'Greening Payment' was introduced under Pillar I of the CAP to supplement existing cross-compliance rules and oblige farmers who receive the direct payment support to meet three ecosystem service criteria. Initially the greening approach would provide "simple, generalized, annual and non-contractual payments" (European Commission 2011) that would create climatic and environmental benefits and permit Pillar II financial resources to be better spent on increasing the ambition of the agri-environment schemes (AESs). Relative to the original proposal, however, greening – as implemented – has affected a reduced area of farmland and encouraged fewer farmers to change their farming practices (Hart, Buckwell and Baldock 2016). Its effectiveness is also uncertain because ecosystem services usually need to be provided at a larger scale than permitted by agricultural management, requiring coordination across landowners (Benton 2012).

Although it is too early for a full end-of-project evaluation, there are a number of analyses that point to the greening programme having a limited impact and poor cost-effectiveness, given that it accounts for a sizeable proportion of the overall CAP budget (European Commission 2016; Gocht *et al.* 2016; Hart, Buckwell and Baldock 2016; Buckwell *et al.* 2017; OECD 2017).

Consumption: convincing stakeholders

There are early signs of sustainability criteria being incorporated into dietary guidelines, in an effort to convince consumers to adjust their consumption patterns to improve nutritional outcomes and to reduce the environmental burden. A recent global review of national dietary guidelines (Fischer and Garnett 2016) found that only four countries had so far included sustainability concerns into their food-based dietary guidelines (Brazil, Germany, Qatar and Sweden). Although most sustainability guidelines to date are health-oriented, reflecting the fact that their creation tends to be led by health ministries, and the link between behavioural change and influence from guidelines is challenging to demonstrate, more widespread inclusion of sustainability concerns in nutritional guidelines could serve to encourage policies that transform consumer demand.

17.4.4 What is the transformative potential of the policy approaches discussed?

Table 17.1 shows the transformative potential of some of the policy approaches discussed above as 'high', 'medium' or 'low'. These qualitative categories are posed as questions to

Box 17.2: Case study: Food losses and waste – multiple policy approaches in Japan

In Japan, multiple policy approaches are used to reduce food waste and losses, such as legislative targets, providing information to educate stakeholders, voluntary codes of conduct, and enabling new institutional arrangements. Those discussed here are primarily concerned with reducing waste in downstream sectors of the supply chain (processors, retailers, hospitality, consumers), but policy approaches are equally required to tackle upstream post-harvest losses. Policies to control and recycle food loss and waste have been implemented since 2000 under the Food Recycling Law, which obligates food manufacture, distribution and catering businesses to recycle waste materials and requires all businesses generating more than 100 tons of food waste annually to report on their waste generation and recycling activities (OECD 2014).

Following generally successful implementation – the majority of food waste associated with business activities is now recycled (as high as 95 per cent in the food manufacturing industry in 2011, though only 23 per cent in the catering industry in the same year [OECD 2014]) – food waste reduction is now a priority over reuse and recycling. Target values for controlling food waste generation have been established for 26 industry groups over the period of 2014-2019. Where unilateral action is challenging for businesses, such as waste resulting from returned goods and excess inventory, the Japanese food industry has formed a working group to address business practices such as changing delivery deadlines, best before date use standards, and labelling methods.

Levels of consumer food waste have changed little in recent years and this is now a priority area; it features prominently in the campaign introduced as a collaboration between six government ministries in 2013, 'No-Food-loss Project', aimed at increasing awareness and changing behaviour related to food losses at all stages of the supply chain (Food and Agriculture Organization of the United Nations [FAO] 2014).

Table 17.1: Agricultural system components, production, food loss and waste, consumption

Agrifood system component	Production	Food losses and waste	Consumption
Policy approach	Economic incentives for ecosystem services: payments for ecosystem services	Various policy approaches, including food recycling laws	Convincing stakeholders: guidelines for sustainable, healthy diets
Promote innovation, including social and institutional innovation, that will not only improve existing approaches, but also entail completely new approaches to meet the needs of society?	Medium Payments for ecosystem services (PES) can be implemented in ways that are innovative – e.g. reforming existing subsidy regimes or developing new market mechanisms. Depending on the design and context, PES may create incentives for actors to develop new approaches.	Medium to high Mandatory targets encourage innovation across businesses in the supply chain to meet the requirements	Low May inform innovation in wider policymaking, but not intrinsically or in isolation. For example, regulatory nutritional labelling may encourage food manufacturers to reformulate products, but in isolation of wider regulation or policy, guidelines, are unlikely to promote innovation (Bailey and Harper 2015).
Enable experimentation, including regulatory experiments to test and demonstrate the feasibility of alternative configurations?	Medium The Common Agricultural Policy (CAP) example demonstrates that PES can enable regulatory experimentation through changing of subsidies. Outcome-based payments are more likely to encourage experimentation among the recipients, rather than activity-based payments.	Low to medium Regulation is unlikely to drive experimentation. Does not proactively drive businesses to experiment, but may create conditions in which they are encouraged to make changes.	Low Does not always enable experimentation, but could be the basis for subsequent regulatory experimentation.
Facilitate new and alternative visions for serving human needs in a sustainable manner?	High Depending on implementation, this approach could pay farmers to deliver new visions for agriculture and landscapes.	High Provides clarity on a low food waste future with expectations of high recycling rates.	Medium Shows a vision but does not aid the delivery of such a vision.
Create and enable new actors or new entrants that provide services to society in a more sustainable way?	Low Generally only works for existing businesses rather than encouraging new businesses to act.	Medium Enables new linkages and new opportunities for resource partnership to be realized by existing businesses, but does not necessarily encourage the entry of new businesses.	Low Creates few enabling conditions for new people to enter the business.
Organize the phase out of existing unsustainable structures?	Low Focuses on reforming the existing businesses.	Medium Reduces the volume of material going to landfill and the viability of existing waste chains, but does not necessarily fundamentally reorganize these structures.	Low Guidelines alone do little to reorganize existing structures – it requires accompanying policy measures to do so.

show the potential of the approach rather than the specific implementation of the instruments. How, and under what circumstances, each approach is implemented in any given situation will largely determine how transformative the outcomes are in that particular instance.

17.4.5 Indicators

Many existing indicators – such as agricultural emissions from different farming sectors – provide valuable information on the environmental sustainability of different parts of the food system, and others are still under development (e.g. SDG indicator 2.4.1 'Proportion of agricultural area under productive and sustainable agriculture'). However, these indicators are usually focused on productive aspects of the food system and tend not to show the efficiency or transformation of the system as a whole. To achieve this we propose a new policy-sensitive national-level indicator for the sustainability and nutrient efficiency of national dietary outcomes: dietary health and sustainability. The dietary health and sustainability indicator would be based on existing annual data series and measure the gap between national consumption patterns and national healthy and sustainable nutritional guidelines. However, as already noted, very few countries currently have nationally defined guidelines on the composition of healthy and sustainable diets. In the absence of such guidelines, alternative global values could be derived from the forthcoming recommendations of the EAT-Lancet Commission on Food, Planet, Health, which intends to reach scientific consensus on what defines a healthy and sustainable diet (EAT-Lancet Commission on Food, Planet, Health 2018; Springmann *et al.* 2018).). The EAT-Lancet Commission recommendations could also be the basis of an aggregate global indicator.

If reliable national data on consumption are unavailable, the dietary health and sustainability indicator would use existing FAO Food Balance Sheet (FBS) data that include annual estimates of national food supplies per capita for each primary commodity and a number of processed commodities that are potentially available for human consumption. However, the FBS data are somewhat crude. The categories are summed to a high level, limiting the level of detail at which analysis can be conducted. Nor do they capture the nature of the food consumed, including whether it is heavily processed – which can have important health implications. Given these shortcomings, governments would be encouraged to gather more accurate data on national consumption patterns as well as to develop nationally appropriate guidelines for healthy and sustainable diets that better reflect the national context.

Table 17.2: Recommended intake for a healthy and sustainable diet

Hypothetical national (or EAT-Lancet Commission) recommended intake for a healthy and sustainable diet	Dietary Health and Sustainability indicator value (annual, national value)
X g/capita per day of fruit and vegetables	Vegetable intake: (+/–) Y per cent of healthy and sustainable levels
X kcal/capita per day of cereals and starches	Cereal and starch intake: (+/–) Y per cent of healthy and sustainable levels
X kcal/capita per day of oils and fats	Oil and fat intake: (+/–) Y per cent of healthy and sustainable levels
X g/capita per day of meat	Meat intake: (+/–) Y per cent of healthy and sustainable levels
X g/capita per day of dairy	Dairy intake: (+/–) Y per cent of healthy and sustainable levels

Food-groupings of national food intake or supply data would be measured to show the proportion by which they exceed or fall short of national guidelines or EAT-Lancet Commission recommended daily intakes for corresponding food groups:

$$[(\text{intake value / recommended intake}) - 1] \times 100$$

A value of zero represents 'ideal' consumption, negative values represent underconsumption and positive values show overconsumption. For example, if there were recommended intake values for the food groups in **Table 17.2**, the dietary health and sustainability indicator would express each country's supply in relative terms **(Figure 17.2)**.

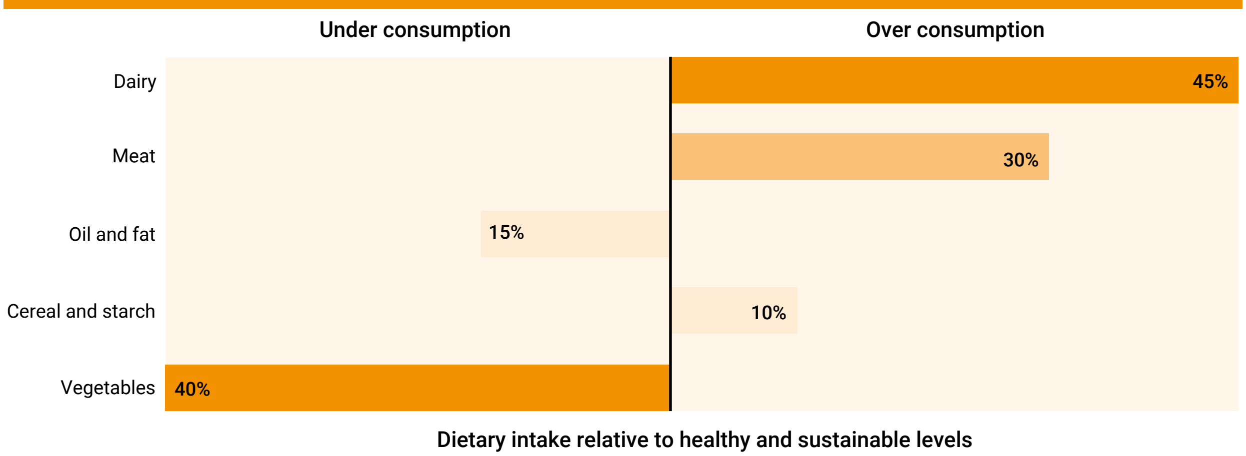
The FBS data show the quantities of food available to the population after accounting for exports and imports, other uses (livestock feed, seed, non-food uses), and losses during storage and transportation. Therefore, the dietary health and sustainability indicator would provide a useful high-level picture of the performance of policies and measures across the entire food system, including actions to reorient agricultural production, trade measures, actions to reduce pre-household waste, and nutritional policies. It would provide an integrated measure of the agrifood system's contributions to progress against multiple SDGs.

Since this proposed dietary health and sustainability indicator is consumption-based, it would not fully reflect the impact of agricultural policies in countries that are large net exporters of agricultural goods, or which produce significant proportions of non-food agricultural products. For example, a country's consumption may appear to be healthy and sustainable, but if consumption is largely based on imported foods, this provides no indication of the sustainability of the agricultural system in that country. On a global basis, however, the dietary health and sustainability indicator would provide an aggregate indication of the sustainability of food production.

17.5 Decarbonizing energy systems

The previous section discussed how agricultural policies tend to focus on supporting farmers rather than providing incentives for improved environmental outcomes. In the complex agrifood system reducing energy use will also play an important role. This section explores the transformative potential that will come from decarbonizing all energy systems.

Figure 17.2: Health and sustainability of country X's dietary intake



17.5.1 What are the most urgent changes required in the system?

Greenhouse gas emissions generated from energy use are a major driver of global climate change. Reducing the carbon footprint of global energy use requires integrated approaches that combine measures to:

i. reduce energy use;
ii. lower the greenhouse gas intensity of end-use sectors;
iii. decarbonize energy supply; and
iv. reduce net emissions and enhance carbon sinks.

There are important co-benefits of these measures, including:

i. reduced costs;
ii. greater energy security; and
iii. human and ecosystem health.

Near-term reductions in energy demand are cost-effective climate mitigation strategies, giving more flexibility for reducing carbon intensity in the energy supply sector, protecting against supply-side risks, and avoiding lock-in to carbon-intensive infrastructures. Delayed scaling up of low-carbon energy systems would make limiting warming over the 21st century to below 2°C very difficult to achieve, and will require much bolder actions such as a larger reliance on carbon dioxide removal in the long term (Intergovernmental Panel on Climate Change [IPCC] 2014).

17.5.2 What elements of the system do the policies seek to address?

Long-term planetary sustainability requires both policy and technological innovations to bring about changes in the choice of fuels, the way they are produced and consumed, and the way in which resources are impacted systemically at every stage of the energy system **(Figure 17.3)**.

Major areas of policy intervention in energy systems, which relate to the SDGs (especially SDG 7) are decarbonization measures that aim to substitute fossil fuels with clean(er) or renewable alternatives, implement efficiency measures that can provide the same service while using fewer resources, enhance access to other energy forms and services, apply land-use and urban planning which considers energy integration (e.g. distributed energy, smart grids, electric vehicle charging networks), and minimizes waste and lock-in of particular technologies by existing systems based on fossil fuels.

17.5.3 What has been done to date and how effective have these measures been?

Mechanisms to address these challenges include carbon pricing (cap and trade systems, carbon taxes and other economic instruments such as fuel taxes, different subventions to renewable energy), regulatory approaches (energy efficiency standards, command-and-control, mandatory decommissioning of old plants), information programmes (addressing behaviour, lifestyle and culture), and addressing administrative and political barriers (including through international cooperation) (IPCC 2014). Policy interventions also include research, development and demonstration (academic funding, grants, incubation support, research centres, public-private partnership, prizes, tax credits, voucher schemes, venture capital, soft and convertible loans), fiscal incentives (grants, energy production payments, rebates, tax credits and reductions, changes in depreciation), public finance (investments, guarantees, loans, procurement), regulations (quantity or quality driven, e.g. renewable portfolio standards, tendering and bidding, feed-in tariffs, green purchasing and labelling, net metering, priority to access to networks or dispatch) (Mitchell *et al.* 2011; International Renewable Energy Agency[IRENA] 2016; International Council for Science 2017; United Nations Industrial Development Organization [UNIDO] 2017).

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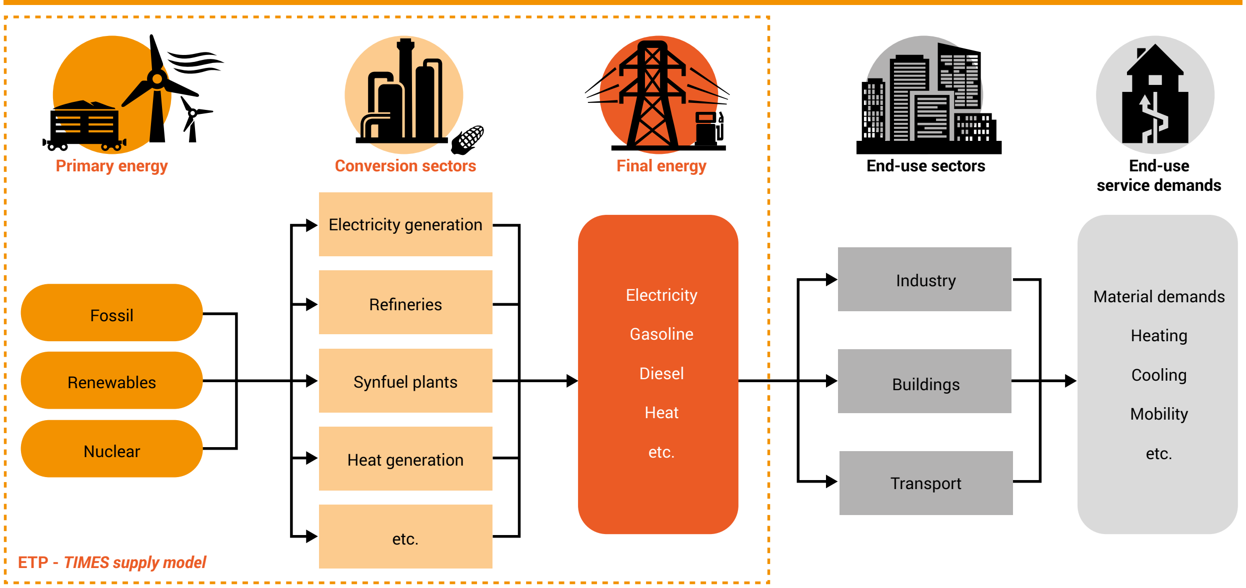
Figure 17.3: An illustrative energy system



Source: Adapted from International Energy Agency (IEA) (2017)

Combined policies for renewable energy and efficiency form the basis of a low-carbon transformation for the global energy matrix. The diffusion, penetration and integration of these policies determine how effective this change can be. The effectiveness of these policy innovations depends on national capacities for action, on the demand for appropriate approaches applied by 'front-runner' countries, on the international policy transfer process, on the enabling conditions for such transfer, and whether policy models are developed at an early stage of the diffusion process to guide other countries (Kern, Jorgens and Jänicke 2001).

17.5.4 What is the transformative potential of the policy approaches discussed?

Building on the momentum created by the 2015 Paris Agreement, a total of 117 Nationally Determined Contributions were submitted, of which 55 included targets for increasing the use of renewable energy, while 89 made reference to renewable energy more broadly (Renewable Energy Policy Network for the 21st Century [REN21] 2017). In 176 countries, targets for renewable energy were a primary means by which governments expressed their commitments. As of 2016, nearly all countries directly supported renewable energy technology development and deployment through some mix of policies.

The other pillar of sustainable energy is efficiency. As shown in **Box 17.4**, improving energy efficiency can generate energy savings and mitigation of associated carbon emissions, encouraging large-scale investment in a competitive and innovative manufacturing industry.

Policy support for renewable energy has been focused mostly on power generation (as in the case in **Box 17.3)**, although implementation for such policies has slowed in recent years in response to tightening fiscal budgets and/or falling technology costs, with auction-based procurement now being a preferred policy approach. In 2014-2016, no new renewable portfolio standards or feed-in (tariffs and premiums) policies were introduced at the national level. However, support for new technologies is still an important driver for transformational change, and lessons from the past can be learned to allow an urgently needed scaling up to address climate change and other socio-ecological challenges.

On the demand side, electric efficiency tackles the purpose of environmental impact mitigation benefits along with improved energy access to cleaner energy. The India case **(Box 17.4)** resulted in spurring large-scale investment in manufacturing, improved standards, raised consumer awareness, generated employment and improved prospects for education, enhanced livelihoods and health.

17.5.5 Indicators

Energy production and consumption are one of the most tracked indicators, due to the heavy cost implications and the geopolitical implications of the energy sector. Because of this it is known that in 2015 the world consumed 13.65 billion metric tonnes of oil equivalent, with energy demand having doubled over the previous 40 years. Of this energy, 81.4 per cent was provided by fossil fuels (coal, oil and natural gas) emitting 32.3 billion tons of carbon dioxide (IEA 2017).

Box 17.3: Case study: Support for renewables in Germany: feed-in tariffs

The German Feed-in Tariff (FIT) policy under the 2000 Renewable Sources Act (Erneuerbare-Energien-Gesetz, EEG) was a remarkable intervention towards low-carbon technology (LCT) diffusion. The main policy design elements were: (i) guaranteed access to the grid for LCTs (purchase obligation); (ii) stable and long-term power purchase agreements (long payment duration); (iii) prices reflecting the varying costs of different LCTs (fixed tariffs with some particularly strong incentives for given technologies such as solar photovoltaics [PV] and onshore wind); and, more recently, (iv) expansion corridors for specific LCTs, limiting capacity additions and household costs. As a proxy for technology diffusion, installed capacity (2016) was 45.4 GW for onshore wind, 4.2 GW for offshore wind and 41.3 GW for solar PV (IRENA 2016). A 2016 amendment to the Act shifted the focus to large investors, with an auctioning scheme according to energy source, plant size and plant location. Design elements proved remarkably stable while flexible. Fixed tariffs led to a surge in deployment and the formation of a domestic solar industry.

In combination with the uptake of onshore wind, and farmers and house-owners profiting from the EEG's conditions, a powerful group of advocates evolved. Driven by a discussion about 'affordability' of continued LCT support schemes, the 2016 amendment replaced the FITs with an auctioning scheme, still technology-specific but aimed at existing large investors rather than at small ones that previously played a large role in the EEG. It was a blueprint for other countries which led to policy diffusion and learning (by doing and by using), ultimately driving down costs on a global scale faster than anticipated. Success was based on long-term guaranteed support and inter-technology differentiation, plus a relatively stable basic policy rationale, adjusted to changing conditions (e.g. cost changes) and minimizing windfall profits. Policy predecessors (1991 onwards) were already established in a highly regulated sector, ensuring fast decision-making, strong support and positive feedback loops. The Fukushima disaster and resulting commitment to nuclear phase-out also helped in creating long-term security in terms of LCT business models. Small decentralized project stakeholders were empowered, as was the domestic industry, in clusters around specific LCTs (wind, solar PV and others).

Household affordability was addressed through the introduction of caps for specific LCTs and factoring in social and environmental costs. Key actors were utilities and industry associations, environmental groups, political parties, and ministries. Some constraining complexity of the energy policies, the existing locked-in technology (fossil fuels, energy consumption), and badly designed policies (e.g. carbon pricing under the EU Emissions Trading System). Later, Fukushima changed the politics in the energy sector, and opponents criticized incentives due to cost inefficiency. However, even with the latest amendment replacing FITs by auctions, technology-specificity remained as a design element. The general public considered the policy necessary and effective (in terms of job and value creation, achieved technology innovation, disruption of incumbent systems, stable investment environment for LCTs) particularly during the first years that the policies were in effect.

Box 17.4: Case study: Demand-side management in India: affordable LED lights for all

The 2013 UJALA (Unnat Jyoti by Affordable LEDs for All) programme in India focused on the demand-side management of residential electricity. Implemented by Energy Efficiency Services Limited (EESL) with support from the Ministry of Power and local manufacturers, efficient LED lamps were distributed to domestic consumers at on-third of the market price. Having demonstrated success within 2-3 years, it covered high upfront costs for a large consumer base: the poorer sections of society. More than 260 million LEDs were sold, with annual savings of over 30 GWh of electricity, mitigation of around 3 million tons of CO_2 (2015) and one of the world's fastest reductions in LED retail market prices (US$12.28/bulb to US$3.07/bulb over 2012-2016).

The sale of new appliances provided energy savings, improved access to modern energy services, growth of domestic manufacturing to an internationally competitive business, better efficiency standards, and a growth in accredited testing laboratories and better consumer awareness. It was an example of low-carbon technology deployment, which created a large market (LED bulbs emerging as the preferred lighting option) using a bulk procurement model, with a technological advancement based on the idea of encouraging business models that could help in meeting the low-carbon emission targets at a faster rate. Domestic manufacturing has increased, and efficiency standards improved with market confidence in the product. Accredited testing laboratories have grown and consumer awareness has increased.

Empowered families had substantial money savings (over US$0.25 billion/year; household electricity bills fell 15 per cent), plus resource savings, emissions mitigation (about 3 million tons CO_2/year), improving quality of life, promoting productivity and local prosperity, and expanding energy access. Such a bulk procurement model allowed for a massive technology advancement. UJALA is an international demand side management showcase, being applied in the second largest world market (worth US$0.33 billion/year and growing) and more recently replicated in Malaysia, also with attempts to cover more appliances, sectors, companies and regions (Chunekar, Mulay and Kelkar 2014; ET Energy World 2017; Energy Efficiency Services Limited (EESL) and IEA 2016; Sundaramoorthy and Walia 2017; India, Ministry of Power 2018a; India, Ministry of Power 2018b).

Despite a slowing trend, global energy demand may still expand by 30 per cent between 2017 and 2040 according to the International Energy Agency (IEA 2018). This amount is the equivalent of adding another China and India to today's global energy demand. At the same time, universal access to electricity remains a challenge. Large-scale shifts in global energy systems are due to the rapid deployment and falling costs of clean energy technologies (chiefly renewables but also natural gas), the growing electrification of energy, and the shift to a more services-oriented economy. Renewable energies are expected to meet 40 per cent of the increase in primary demand, capturing two-thirds of global investment in power plants to 2040 as their costs drop, enabling policies to continue to support them, and the transformation of the power sector is amplified by millions of electricity end users investing directly in distributed solar photovoltaics, with an increasing share of smart connected devices and other digital technologies. Electrified transport will grow, pushing the global electric car fleet to 280 million by 2040, from the present 2 million. Global investment in electricity overtook oil and gas investment but the challenge of decarbonizing the global power supply remains. Natural gas plays an important role in replacing oil and coal, with 80 per cent of the projected growth in demand for natural gas taking place in developing economies and the shift towards a more flexible, liquid, global market (IEA 2018).

17.6 Towards a more circular economy

The three previous sections of this chapter illustrate some of the effects of a linear economic system on the global environment. In this section, we analyse the use of materials/resources throughout the value chain from extraction to waste in the prevailing economic systems and examine approaches for developing a circular economy.

17.6.1 What are the most urgent changes required in the system?

For several centuries, most societies have pursued development using a linear economy model, where the majority of resources are extracted, processed, converted to products (some of which have a very short lifespan) and are then disposed of after use (commonly referred to, as the "take, make, waste" process). Within this economic model, only a small percentage of materials is reused or recycled (the exception being commodities like iron and gold). Instead, at the end of life they are considered waste and there is often a high price, financially, socially and environmentally to dispose of this waste.

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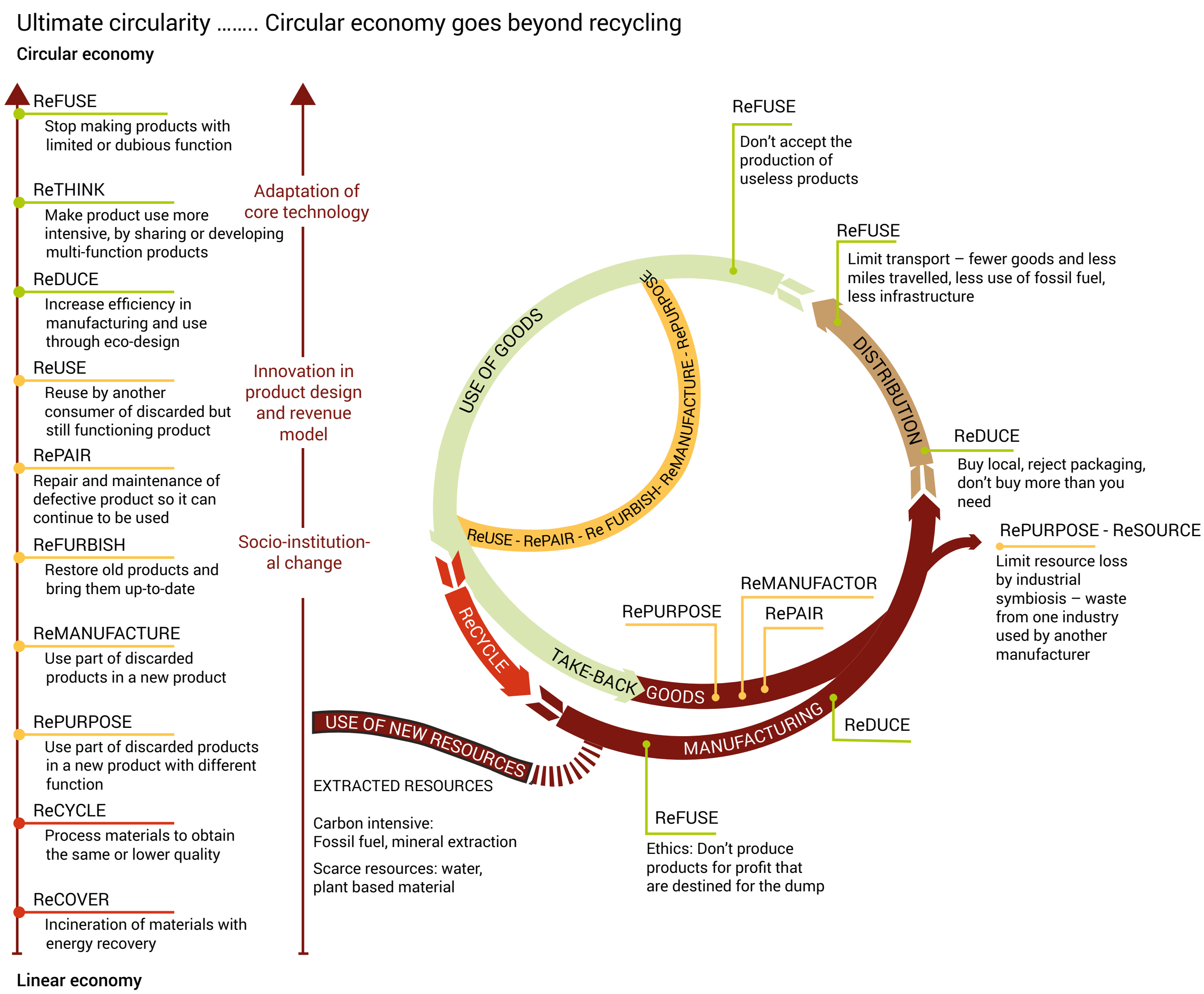
The linear economy assumes that there will always be an abundant supply of raw materials and unlimited capacity to dispose of waste in the natural environment. However, as can be seen from Part A of this report, human societies cannot continue to operate in this way if we want to meet the demands of a growing population, preserve the health of the planet, and ensure that future generations are able to prosper. Continuing to extract natural resources such as minerals using this model implies an increasing environmental impact to extract ever diminishing ore grades. The example of fossil fuel resources shows that the capacity of ecosystems to absorb emissions is limited. Within the sustainability framework, some resources are finite and current levels of consumption are not compatible with reaching the SDGs. An alternative is to build sustainable economies that recognise the value of natural resources through a 'circular economy' **(Figure 17.4)**.

The components and strategies of a circular economy model were first identified in the early 1980s and refined in following decades (Stahel and Reday-Mulvey 1981; Ayres 1994). These earlier models referred only to waste management – collection, separation, recycling, reuse. Today, there are many circular economy strategies being applied by individuals, businesses and governments. These can go beyond dealing with waste to include better product design, reduced consumption and sustainable materials management. The common aim is to use resources in the most efficient way for the longest possible time. The resources circulate through various processes, being reused, repaired, redesigned or remanufactured, which reduces the need for new raw materials and minimizes waste **(Figure 17.4)**. When faced with persistent environmental problems such as climate change, resource scarcity and biodiversity loss, adopting resource circularity makes sense; however, society has been slow to adopt this model or has simply failed to take the actions necessary for large-scale change.

Speeding up the transition to a circular economy involves a large shift in business and consumer thinking, demanding the adoption of sustainable production and consumption processes. Fuenfschilling and Truffner (2014) identify breaking down long-standing rigid and interdependent system structures as the main challenge. The difficulty stems from having to enact large-scale socio-institutional change, which may require radical new ways of thinking and adjustment to normal customs and beliefs (Potting *et al.* 2017). Moving from

Figure 17.4: Building a circular economy



Source: Based on Stahel (2016) and Potting *et al.* (2017).

the established way of thinking involves the development of new laws and policies, which need revised, redesigned or new business models that integrate industries and incorporate a longer-term perspective, the internalization of the environmental and social costs of extraction, production and disposal, innovative technologies, and changes in consumer use patterns. Actions that can contribute to accelerated transformation have been outlined by the Government of the Netherlands (2016) and include the following.

- Decreasing demand for raw materials by increasing the efficiency of raw material use in the supply chain.
- In instances where raw materials are required, replacing fossil-based, scarce and non-sustainably produced raw materials with sustainably produced, renewable and readily available raw materials.
- Developing new innovative low-carbon production methods and smart product design.
- Promoting thoughtful consumption (e.g. reuse, smart design, extension of product life through design and repair, use of secondary and recycled materials, sharing economy).

Circular economy strategies have also been developed by Germany, Finland, Denmark and Slovenia. France, Italy and Spain have their road maps developed as well.

The circular economy promotes a production and consumption model that includes restoration and regeneration where possible (Ellen MacArthur Foundation 2015; Smol, Kulczycka and Avdiushchenko 2017). It ensures that the worth of products, materials, chemicals and resources is maintained in the economy at their highest utility and value for as long as possible (European Commission 2015; Stahel 2016). The circular economy, therefore, means reducing waste during production, ensuring asset recovery including waste utilization, and developing obsolescence prevention pathways in product and urban system designs through sustainable materials management **(Box 17.5)**. It also means ensuring product and service delivery with energy and materials from renewable sources, while changing business models to match these objectives (Ghisellini, Cialani and Ulgiati 2015; Rizos, Tuokko and Behrens 2017).

The circular economy preserves raw materials, thereby decoupling economic growth from the use of resources and its associated environmental externalities, including carbon emissions. However, in some cases the appearance of growth decoupling in one sector or territory can mask a continued environmental and social impact somewhere else (details in Ward *et al.* 2017). Ward *et al.* (2017) cite substituting one non-renewable resource for another (e.g. the cleaner energy systems that replace fossil fuels still require non-renewable resources) and shifting the cost somewhere else (e.g. importing resource-intensive consumer goods from developing countries).

17.6.2 What are the elements of the system that the policies seek to address?

Policies that support the transition to circularity are being developed and implemented in many places and involve a range of different approaches. Early examples include the German Closed Substance Cycle and Waste Management Act introduced in 1996 to recover materials from municipal and production waste (Germany, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety [BMU] 2011) and the Japanese recycling initiative Basic Law for Establishing a Recycling-Based Society (Environment Agency Japan 2000). These actions are examples of what has become known as the 3Rs of reduce, reuse and recycle, and are the foundation of green manufacturing and consumption (Jawahir and Bradley 2016). However, in the last decade the focus has expanded from 'green' to sustainable manufacturing – for example, the 6Rs of manufacturing, which in addition to reduce, reuse and recycle, include recover (for a subsequent life cycle), redesign (the next generation of products) and remanufacture (meaning restoration to an 'as new' form) (Jawahir and Bradley 2016; **Figure 17. 5)**.

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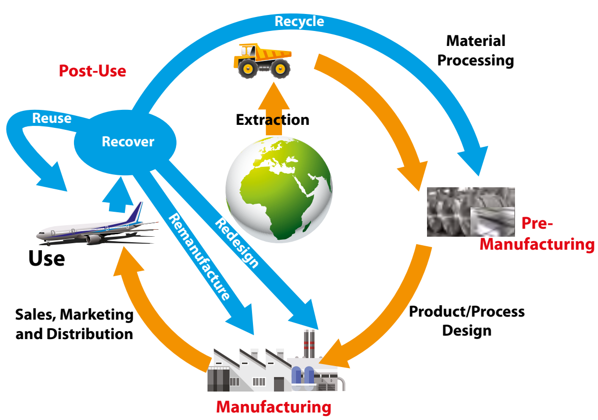
Box 17.5: Sustainable materials management

Sustainable materials management (SMM) is a policy approach that expands the focus of waste management to the whole life cycle of a material – from extraction to end of life. It seeks to maintain the availability of products and services by conserving valuable resources and keeping them in circulation indefinitely. One of the key aims of the holistic management approach is to reduce impacts on the environment across the whole life cycle of a resource. Producers and manufacturers need to extend sustainability across the value chain – this involves ensuring the sustainability standards of all suppliers, integrating sustainability into the design process, and identifying and addressing any negative social and environmental impacts.

Reducing the volume of waste produced and increasing material recovery are essential components of SMM (United States Environmental Protection Agency [US EPA] 2015). SMM promotes resource efficiency, which includes minimizing the economic, environmental and social costs of a production process and resource productivity, defined as the effectiveness with which natural resources are used (OECD 2012).

Figure 17.5: Closed-loop material flow diagram of 6R elements and the four life cycle stages



Source: Jawahir and Bradley (2016).

Table 17.3: Examples of policy focus to achieve key elements of the circular economy

Key elements of the circular economy	Policy examples	Result examples
Design for the future	EU Ecodesign Directive – ensures energy efficiency of products, such as household appliances, by setting minimum efficiency requirements (EU 2009).	It is estimated that the Ecodesign Directive will deliver a 16 per cent reduction in the primary energy consumption of 35 product groups compared with the consumption of these products in 2010. For example, the energy efficiency of televisions, under the Ecodesign scenario it is predicted to improve by a factor of 25 (measured from 1990) by 2030 (European Commission 2017).
Market-based instruments – green taxation	Taxes on virgin materials such as sand, gravel and rock used in the construction industry have been introduced by 16 EU states.	The United Kingdom of Great Britain and Northern Ireland introduced a tax on aggregates in 2002. Since the introduction of the tax, primary aggregates use has reduced by approximately 40 per cent per unit of construction (Ettlinger 2017).
Incorporate digital technology	Republic of Korea has some of the world's fastest internet speeds, with connections to more than 90 per cent of the population. The government has provided economic support for broadband infrastructure development, subsidies to ensure connectivity, and measures to stimulate information technology literacy (Falch and Henten 2018).	Streaming music reduces resource use and costs 80 per cent less than the cost of producing and distributing of compact disks (CDs) (Lacy 2015). The Republic of Korea was the sixth top music market in 2017 and has the largest number of paid music subscribers (International Federation of Phonographic Industry [IFPI] 2018).
Collaborate	In Sydney, Australia, the city council introduced policies to promote car sharing, including the provision of designated car-share parking spaces; and online listing of private vehicles participating in peer-to-peer sharing schemes (City of Sydney 2016).	GoGet is an Australian car-sharing company, operating in large cities. Members have access to a range of vehicles including cars and vans (GoGet https://www.goget.com.au).
Use waste as a resource	In 1997, Denmark introduced legislation that banned sending waste that could be recycled or incinerated to landfill. In 2015, a new law was introduced, the Environmental Technology Development and Demonstration Programme (MUDP). This includes a subsidy scheme, innovation partnerships and international cooperation to find resource-efficient solutions to environmental problems (Denmark, Ministry of Environment and Food n.d.).	The Kalundborg Symbiosis in Denmark is a network of businesses that was the first industry group to fully develop industrial symbiosis. The collaboration includes a coal-fired power plant, fish farming, fertilizer production and a host of other manufacturing and industrial operations (Kalundborg Symbiosis 2018).
Rethink the business model	New business models that utilize technologies are emerging, such as blockchain. Estonia, for example, has established an e-residency scheme to encourage entrepreneurs. E-residency provides anyone with a digital ID that allows them to access Estonia's e-services for online business development and management from anywhere in the world.	The China Construction Bank Corporation (CCB) is using the IBM Blockchain platform to improve procedures for the sale of its insurance products.
Preserve and extend existing products	The right to repair – the EU is preparing legislation making it mandatory for companies to provide spare parts and diagnostic tools that would make it cheaper and easier to repair products (European Parliament, Committee on the Internal Market and Consumer Protection 2017)	Inrego, a Swedish firm, is refurbishing electronic equipment such as laptops, personal computers, monitors and phones (European Remanufacturing Network 2018).
Prioritize regenerative resources	Norwegian policies to support battery electric vehicles (BEV): zero annual road tax (2018); 40 per cent reduced company car tax (2018); 50 per cent price reduction on ferries (2018); zero re-registration tax for used zero-emission cars (2018); free municipal parking in many cities (Norsk elbilforening 2018).	In Norway, incentive programmes to encourage use of BEVs began in the early 1990s. Norway currently leads the world with 21 per cent BEV market share (cf. Australia, where there is limited incentive and BEVs have 0.2 per cent of the market (ClimateWorks Australia 2018).

China adopted the circular economy as a development strategy in 2002, and this was given legal effect in 2009 through the Circular Economy Promotion Law (China, National People's Congress 2008). The European Commission released a 'Roadmap to a Resource Efficient Europe' in 2011, which was replaced in 2015 by 'Closing the Loop: An EU Action Plan for the Circular Economy' (McDowall *et al.* 2017). Both Europe and China were following earlier research and policy work in the United States of America, Japan and Europe that focused on waste management.

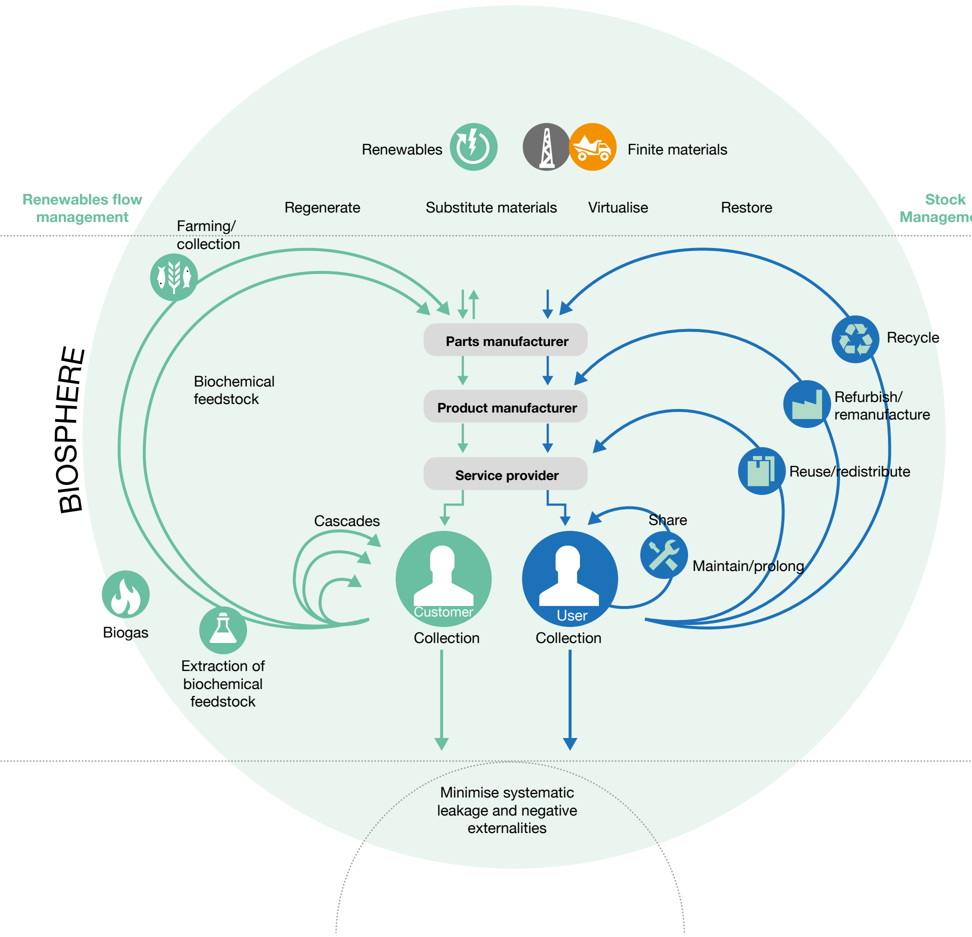
Box 17.6: Case study: Ellen MacArthur Foundation – A toolkit for policymakers in delivering the circular economy

The Ellen MacArthur Foundation, a UK-based non-governmental organization, has been a leading proponent of the circular economy, funding extensive research and education programmes. In 2015, the foundation partnered with the Danish Business Authority to develop a toolkit for policymakers (Ellen MacArthur Foundation 2015). In the development of the toolkit and subsequent pilot studies, the authors identified seven key insights which provide evidence of the potential economic, environmental and social benefits of moving towards a circular economy.

- A circular economy fosters more innovation, resilience and productivity, resulting in increased gross domestic product (GDP) and jobs, and reduces greenhouse gas emissions and virgin non-renewable resource consumption.
- Policymakers can break down the non-financial barriers that challenge the circular economy.
- There is no overarching solution that will instigate a circular economy – each sector must be analysed and tailored policies should be instituted.
- An overhaul of financial systems and the way we measure economic performance (i.e. currently excluding externalities such as environmental damage or social dislocation) will help illuminate the real value in transitioning towards a circular economy and the real cost of business as usual.
- Business needs to lead the way in identifying circular economy opportunities.
- Even developed countries that are moving towards a circular economy can increase the rate of change by scaling up and fostering enabling conditions across all sectors.

There needs to be policy coordination across countries as value chains extend across borders.
The policy environment is expanding, with states and other stakeholders such as the Ellen MacArthur Foundation playing an important role in promoting the circular economy transition to business and industry **(see Figure 17.6)**.

Figure 17.6: Outline of a circular economy



Source: Adapted from Cirular Norway (n.d).

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17.6.3 What has been done to date and how effective have these measures been?

Many governments have introduced policies and regulations that address aspects of the circular economy. Policies supporting the circular economy can focus on one or more elements of the 'take, make and waste' process. While many policies have tended to address waste through recycling and resource recovery, there are significant gains to be made at the earliest stages of product design and manufacture. For example, products can be designed using eco-design principles, to use less material and last longer. They can be refurbished or repaired and made of non-toxic materials that are simple to recycle.

Policies that encourage eco-design also need to consider the potential adverse health, gender and developmental impacts of poorly planned policies (e.g. toxic exposures for women and children from recycling electronic waste). About 15 million people are involved in informal waste recycling of plastics, glass, metals and paper where these activities are a risk both to the environment and to the people performing the tasks (Yang *et al.* 2018). Individuals performing resource recovery, especially e-waste pickers in developing countries, risk considerable occupational and environmental health threats (Velis 2017). Women and children are among the vulnerable groups working in this informal sector who face exposure to hazardous chemicals and heavy metals (Heacock *et al.* 2016), with few to no measures for prevention or treatment (Han *et al.* 2018).

Policies can also support the move from managing waste to more environmentally sustainable outcomes, by focusing on behaviour change. These policies, which are often developed from grass-roots initiatives, aim to limit the amount of waste produced and increase material recovery (Silva *et al.* 2017).

Europe has established policies for implementing the circular economy, while in other areas this has happened at a national or subnational level. There have also been some international policy initiatives that align with, or promote, a circular economy approach, especially with regard to waste minimization (e.g. the Basel and Stockholm conventions). The new approach of green (or sustainable) chemistry is working to develop alternative solutions aimed at eliminating or at least significantly reducing hazardous chemicals and eventually their presence in the environment (Weber, Lissner and Fantke 2016). One of the challenges in relation to chemicals and the circular economy is increasing recycling and reuse, while making sure consumers are not at risk from exposure to substances of concern that may be present in products and passed on through waste (European Commission 2015). For some chemicals and toxic metals, such as persistent organic pollutants (POPs) and mercury, final disposal may be a better option than recycling and reuse.

17.6.4 What is the transformative potential of the policy approaches discussed?

A transition to a circular economy will be required in order to achieve the SDGs. There are insufficient natural resources to sustain the continued expansion of a global economy based upon a linear economic model. The circular economy offers opportunities not only to address fundamental resource constraints but also to create a more just and inclusive economic system (Raworth 2012). Circular economy policies therefore carry major transformative potential to address cross-cutting policy challenges.

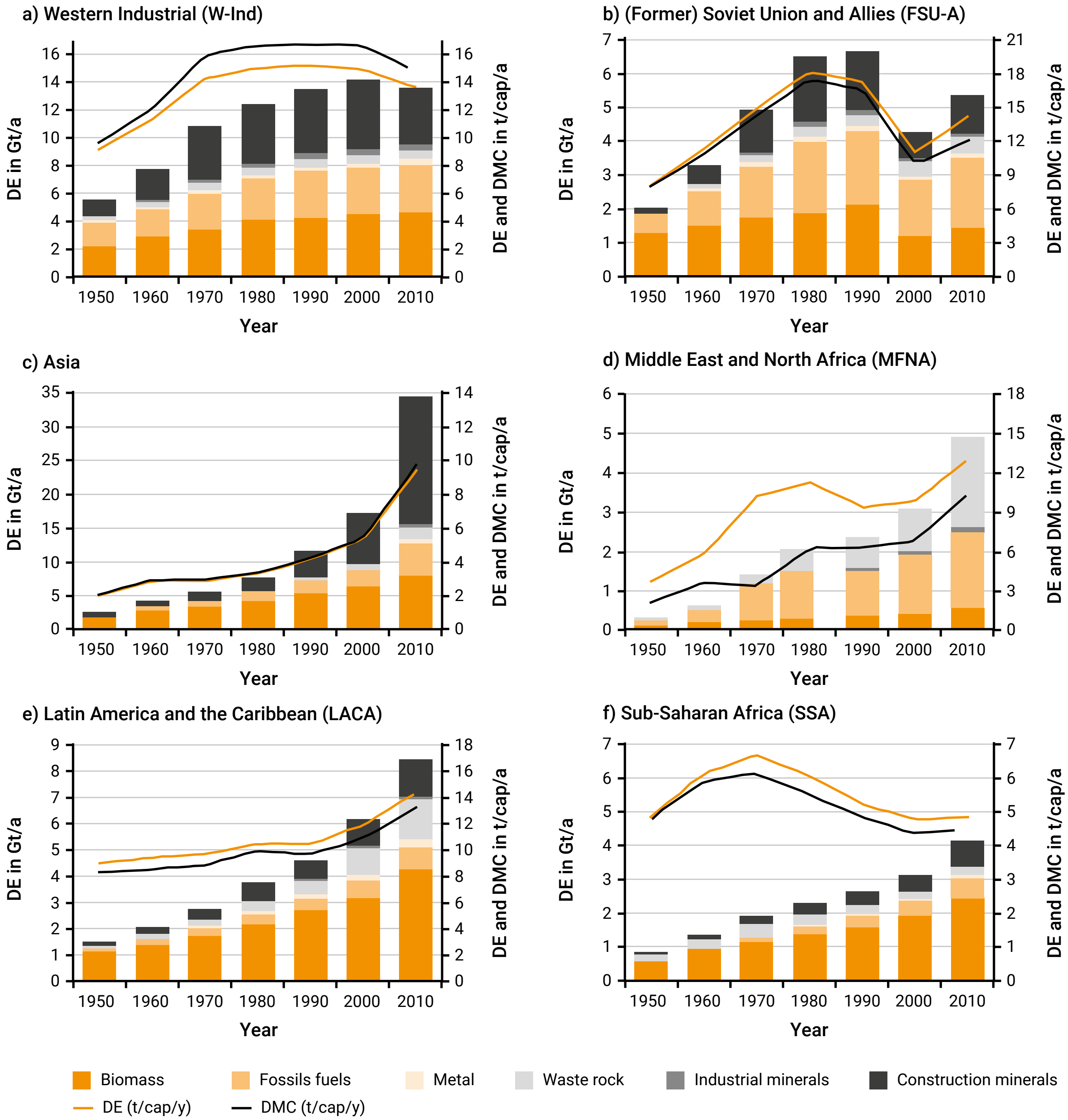
17.6.5 Indicators

No indicator provides a single measure of progress towards a circular economy. However, there are several existing indicators of performance in areas that directly or indirectly contribute to the achievement of a circular economic system. Sustainable resource management, societal behaviour, business operations, material flow accounting or analysis are among a number of measures that have been proposed (Geng *et al*. 2012; Wiedmann *et al.* 2015; United Nations Environment Programme [UNEP] 2016). Taking into consideration linkages with the SDGs, we identify two policy-relevant indicators of circularity.

Indicator 1: Domestic material consumption (DMC) (SDG indicators 8.4.1, 8.4.2 and 12.2.2)

Domestic material consumption measures the territorial consumption of primary materials used in the economy, whether these are domestically sourced or imported. This indicator allows a comparison to be drawn between regions and states in per capita material consumption over time. DMC can also be used to estimate the amount of waste that may be generated in a given region. Domestic extraction (DE) is the amount of materials extracted in a given territory. DMC is higher than DE in net material importing countries and lower than DE in net material-exporting countries **(Figure 17.7).**

Figure 17.7: Domestic extraction and Domestic material consumption



The figure shows data on extraction, trade, and apparent consumption of materials for six regions in Gigatonnes per year (Gt/a) and in per capita values per year (t/cap/a). DE: domestic extraction; DMC: domestic material consumption.

Source: Schaffartzik *et al.* (2014).

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Indicator 2: Societal behaviour (SDG indicators 12.2.1 and 12.2.2)
In addition, developing a circular economy will involve people changing their consumption behaviour and choosing products and services that conserve resources. Sharing resources, a common strategy in many subsistence economies, is being increasingly adopted around the world. Sharing of expensive or infrequently used products such as cars, bikes, holiday houses, camping and other recreation equipment may be organized as formal schemes or informal agreements within communities **(Figure 17.8)**.

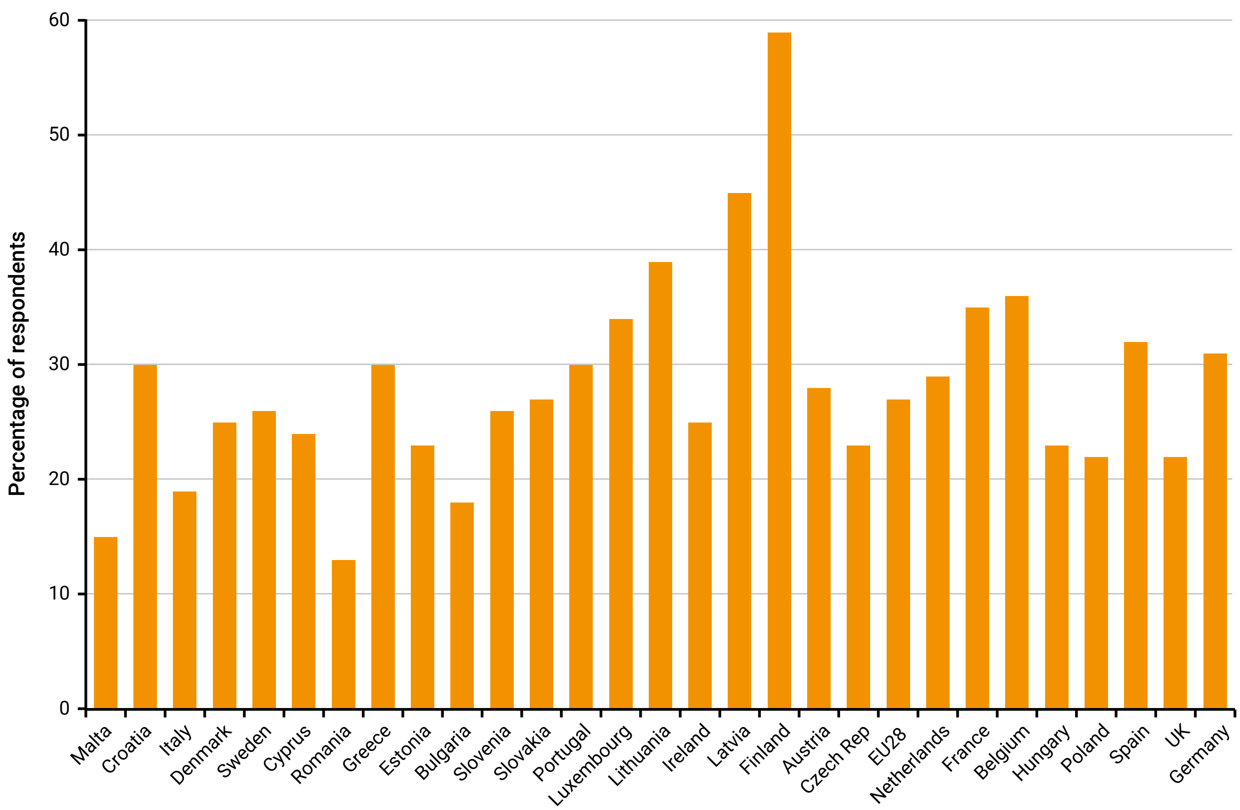
17.7 Conclusions

The cross-cutting nature of sustainability issues is well illustrated by the interactions across SDGs (Nilsson, Griggs and Visbeck 2016; Biermann, Kanie and Kim 2017; International Council for Science 2017). Meeting one goal or target will not guarantee that other SDGs will be achieved, just as some Millennium Development Goals (MDGs) were achieved in some parts of the world but not in others (Boas, Biermann and Kanie 2016; Kim 2016; Underdal and Kim 2017; Young 2017). This lesson is not new, but the overdue shift towards systemic policy approaches is beginning to occur. Some go as far as to argue that "the single most important [environmental] problem is our misguided focus on identifying the single most important problem" (Diamond 2005). The systems approach to environmental policy development and implementation, discussed in this chapter, can address multiple global goals and is no longer an option but is the only way forward for societal transformation to achieve global sustainability.

This chapter highlights the complex linkages between sustainability issues and the ways in which these present both challenges and opportunities. They are challenges in the sense that cross-cutting issues are difficult to address individually through incremental steps and in isolation from one another. As concluded in the thematic chapters of Part B (Chapters 12-16), many well-intended environmental policies and measures have had limited success. Policy improvements are visible, but they have not been made at a sufficient rate or scale. New sustainability issues have emerged that have greater complexity, often due to the unanticipated ways through which existing issues have interacted with one another. Some of the unwanted outcomes of interaction between global drivers in turn act as drivers for further suboptimal outcomes (Walker *et al.* 2009).

As the analyses in this chapter have shown, however, systems policy approaches with transformative potential do exist. If key leverage points can be identified in a system and the right policy interventions are made (Meadows 2008), transformative change leading to innovations will lead to net positive effects. Even small-scale interventions can sow the seeds for the larger systemic change that is required to deliver the SDGs. This chapter chose four socioeconomic systems to illustrate the transformative potential of the systemic approach to environmental policy intervention.

Figure 17.8: Citizen engagement in sharing: the percentage of 2013 survey respondents who had engaged in a sharing scheme, either formal or informal in the previous 12 months



Source: Flash Eurobarometer 388 (2013)

Environmental, social and economic systems need to be understood and analysed by appreciating their complexity. Some understanding of a system is a prerequisite to identifying leverage points, that is, where 'seeds can be sown'. Acknowledging that there is no policy panacea (Ostrom 2007), various clusters of policies can then be deployed, and some degree of redundancy can be helpful as a policy safety net (Low *et al.* 2003). It is very difficult to predict whether a policy will work effectively to solve a cross-cutting issue without producing significantly perverse and unintended consequences. Attention to one element of a cross-cutting issue can lead to environmental problem shifting – both transboundary and trans-sectoral, or trade-offs and spillovers (Kim and van Asselt 2016). Adaptive governance or management approaches are therefore required that use experimentation (Hoffmann 2011) to build on lessons learned rather than 'reinventing the wheel'.

An effective response to cross-cutting environmental policy challenges requires cooperation and collaboration among a multitude of actors and institutions across issues, sectors, levels and jurisdictions. The transformation pathway for achieving human dignity and environmental sustainability this century requires a whole-of-system approach that can catalyse rapid technological innovation and economic and cultural paradigm shifts.

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GEO-6 builds on the findings of previous GEO reports, including the six regional assessments (2016), and outlines the current state of the environment, illustrates possible future environmental trends and analyses the effectiveness of policies. This flagship report shows how governments can put the world on the path to a truly sustainable future. It emphasizes that urgent and inclusive action is needed by decision makers at all levels to achieve a healthy planet with healthy people.

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