Netherlands Environmental
Assessment Agency

Roads from Rio+20

Pathways to achieve global sustainability goals by 2050

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Summary and Main Findings to the full report

PBL Netherlands Environmental Assessment Agency

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Roads from Rio+20. Pathways to achieve global sustainability goals by 2050

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PBL Netherlands Environmental Assessment Agency is the national institute for strategic policy analysis in the field of the environment, nature and spatial planning. We contribute to improving the quality of political and administrative decision-making, by conducting outlook studies, analyses and evaluations in which an integrated approach is considered paramount. Policy relevance is the prime concern in all our studies. We conduct solicited and unsolicited research that is both independent and always scientifically sound.

Foreword

This report was written in the run-up to Rio+20, the UN conference that will revisit the outcomes of its 1992 precursor. Rio+20 aims to set the agenda for sustainable development policies in the coming decade, with its focus on a next generation of sustainable development goals, a green economy and the reform of the institutional framework for sustainable development.

In 1992, governments agreed to work towards eliminating poverty while keeping global environmental problems within acceptable limits. Although progress has been made in certain areas, overall, the conclusion must be that we have failed to realise the vision that resulted from the 1992 Rio conference.

Could that vision still be achieved? This report analyses possible pathways to achieve a set of internationally agreed sustainable development goals for food, land and biodiversity, as well as for energy and climate. It explores how environmental and development objectives could be reconciled, in actual practice. Furthermore, it shows the level of effort that would be required to meet these goals, the possible pathways along which that could be achieved, as well as the synergies, trade-offs, and possible directions for policy-making.

However, the world has changed, enormously, since 1992. The lack of progress, so far, in combination with the level of subsequent effort that would be needed to meet sustainable development goals, the current economic crises and the difficulties of coming to effective multilateral solutions may result in a sense of pessimism about what could be achieved in the future.

The urgency for progress towards a more sustainable development in view of human well-being and planetary stewardship requires prompt action. This leaves us with no alternative other than a pragmatic search for ways to go forward. We suggest a pragmatic approach that could be further developed into ‘roads‘ that lead us from the Rio conference into the future. This approach builds on the observation that many sustainability initiatives are being developed within civil society and by business community, and that a scale up of such initiatives, in itself, could be worthwhile. In this report, we look for new connections between policy, societal initiatives and learning. Our pragmatic approach includes converging on a shared vision for 2050, combined with

short-term targets, making sustainable development the new ‘normalcy of society’ and finding complementary ways of achieving international collaboration.

This report builds on previous PBL assessments of global sustainability problems and the contributions we have made to assessments by international organisations, such as UNEP and OECD, and links to our trend report The Energetic Society (2011). Following the Rio+20 conference, PBL intends to publish its assessment of the implications of the Green Economy concept for the Dutch economy.

Professor Maarten Hajer

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Summary

In 1992, governments worldwide agreed to work towards a more sustainable development that would eradicate poverty, halt climate change and conserve ecosystems. Although progress has been made in some areas, actions have not been able to bend the trend in other, critical areas of sustainable development – areas such as those providing access to sufficient food and modern forms of energy, preventing dangerous climate change, conserving biodiversity and controlling air pollution. Without additional effort, these sustainability objectives also will not be achieved by 2050.

This report analyses how combinations of technological measures and changes in consumption patterns could contribute to achieving a set of sustainability objectives, taking into account the interlinkages between them. The potential exists for achieving all of the objectives. The fundamental question here relates to the type of governance structures that could bring about the transformative changes required to meet the sustainable development objectives. We suggest a pragmatic governance approach that consists of a shared vision for 2050, strengthened short-term targets, and strong policy actions by governments, building on the strength of civil society and business.

1 Identifying the problem

Although the 1992 Rio Conference resulted in many activities aimed at sustainable development, historical trends have not been reversed in key areas
Moreover, projections indicate that, without new policy initiatives, sustainable development goals will not be achieved in the coming decades, either. The world has

seen improvements in welfare, reductions in poverty as well as local environmental problems. In two important spheres – *food, land and biodiversity* and *energy and climate* – policies have not led to a reversal of historical, unsustainable trends. Moreover, projections suggest that long-term sustainability objectives will not be achieved unless a significant new policy effort is made.

The number of people without sufficient food has remained almost constant, at around 800 to 900 million people, since 1992. Although economic growth is projected to lead to improvement, it is not likely to be enough to fully eradicate hunger by 2050. Around 1 billion people lack access to electricity, and almost 3 billion people still rely mostly on solid fuels for cooking and heating. This has negative impacts on their health and hampers economic development. Up to 2050, this is expected to improve only to a limited extent.

Since 1992, biodiversity has declined significantly and this is expected to continue. In addition, greenhouse gas emissions have increased rapidly and are projected to increase even further. To achieve the 2 °C target, however, emissions would need to be halved by 2050, compared to 1990 levels. Finally, air pollution levels in many parts of the world are projected to remain high and in some places may even increase, leading to serious health losses.

2 Could a set of ambitious sustainable development objectives be achieved?

There are alternative pathways along which the sustainable development goals could be achieved

Using a backcasting approach with the integrated assessment model IMAGE, this study analyses effort levels and measures required to achieve a set of sustainable development goals. These goals are all derived from existing international agreements (e.g. the Millennium Development Goals, UNFCCC and UN CBD). The focus is on: 1) eradicating hunger and maintaining a stable and sufficient food production, while conserving biodiversity; and 2) ensuring access to modern energy sources for all, while limiting global climate change and air pollution. The analysis explores different combinations of technological measures and consumption changes. It shows that each pathway could be successful, but would also encounter particular problems, such as the environmental impacts of intensive agriculture or the difficulty of influencing consumption patterns. Although not all combinations are possible, combining elements of the pathways could make the response strategy more robust. This would also do justice to the pluriformity in society as different elements are appealing to different actors.

Eradicating hunger and maintaining a stable and sufficient food supply while conserving biodiversity

In order to feed a growing and overall wealthier population, food production needs to increase by around 60% in the 2010–2050 period. However, a slowdown of the increase in agricultural productivity, increasing demands for bio-energy and wood products, as

well as climate change, will result in increasing competition over land. This, in turn, could result in higher and more volatile food prices and increasing pressures on biodiversity and ecosystem services.
In this situation, substantial effort is needed on multiple fronts to meet sustainable development goals, including improved yields (especially in areas with relatively low yields compared to their potential), waste reduction, climate change mitigation, better land management policies and the expansion of protected areas. Lifestyle changes towards less resource-intensive consumption patterns may also contribute significantly to the achievement of these targets. Finally, to eradicate hunger, it will be necessary to increase access to food for the poorest households.

To implement these actions, four fundamental short-term policy priorities can be defined: 1) create conditions to accelerate sustainable agricultural intensification, 2) ensure a more robust food system to reduce hunger, 3) mainstream biodiversity considerations in land-use planning and management, and 4) promote changes, such as in consumption patterns. Clearly, these priorities are likely to differ across countries, depending on their income levels.

Ensuring access to modern energy sources for all, while limiting global climate change and air pollution
As is the case for food, energy production also is expected to increase by around 60% over the next four decades. However, greenhouse gas emissions would need to be halved in order to achieve the 2 °C target to limit climate change.

The analysis shows that access to modern energy could be improved by financial instruments to lower the cost of modern fuels and stoves, distribution programmes for improved stoves, and ambitious electrification programmes, all targeted at the poorest households. The development and health benefits of such a transition are substantial. In order to reduce greenhouse gas emissions, improved energy efficiency must form an essential part of the response strategy. Standards and financial tools (e.g. taxation) could be effective policy instruments to unlock existing potential. In addition, further electrification in the transport and household sectors could ensure more flexibility in reducing emissions. On the supply side, by 2050, around 60% of all energy would need to come from non-CO_2 emitting energy sources, such as renewables, bio-energy, nuclear power, and fossil fuel combined with CO_2 capture (the current share of these technologies is 20%). Reducing non-CO_2 greenhouse gas emissions is also part of an effective strategy, because of low costs and co-benefits, although the long-term mitigating potential is limited.

To implement these long-term changes, the main focus for the energy sector for the next ten years would be in the following areas: 1) substantially increasing efforts to ensure modern energy for all; 2) peaking global greenhouse gas emissions around 2020; 3) introducing appropriate pricing instruments; and 4) ensuring sufficient financing and

reform of international climate policy, including R&D efforts. Again, priorities in these areas are dependent, among other things, on income level.

There is no fundamental trade-off between eradicating hunger as well as providing full access to modern energy, on the one hand, and achieving environmental sustainability, on the other

Eradicating hunger and providing access to modern energy for all (beyond production increases that result from population and economic growth) would not necessarily negatively affect global biodiversity or climate change. Even if access to modern fuels for cooking and heating for the poor is achieved with fossil-fuel-based products, this would result in only a small increase in CO_2 emissions, (partly) compensated by reduced emissions from deforestation and of black carbon. Furthermore, the additional increase in food production required to eradicate hunger would be small compared to current production levels and the overall increase to keep up with population growth and economic development. If hunger eradication would be facilitated by a redistribution of current consumption levels, the required increase in production would be even less.

For both of the above thematic areas (land and energy), marginal improvements will not suffice; large, transformative changes are needed to realise sustainable development

Although, technically, environmental and development goals could be achieved, this would require rather bold, systemic changes. Decoupling of CO_2 emissions from economic growth needs to take place at 4% to 6% a year, over the next decades, to meet the climate target of a 2 °C maximum temperature increase by 2100. This is to be compared to the historical rate of 1% to 2%. In agriculture, an average productivity increase of around 1% a year would be needed to provide sufficient food for all, while limiting biodiversity loss. This rate is comparable to historical improvement rates, but will be more difficult to achieve in the future.

3 How to implement transformations?

A new, more effective approach to sustainable development is needed

The outcomes of this study are consistent with earlier studies that focused on specific problems of sustainability; all show that there is sufficient technical potential to meet sustainability objectives. However, it has to be concluded that the approaches used to unlock this potential of achieving the internationally agreed ambition, so far, has not been very successful. Moreover, the geo-political and societal context has changed substantially since 1992. It is therefore paramount to reflect critically on the current governance structures in order to pave roads that more effectively lead from Rio to a sustainable 2050.

This report suggests a governance approach that is based on a shared vision with long-term goals and consistent short-term targets, combining strengthened government actions with the numerous civil and corporate initiatives worldwide
Adaptations to the current approach would consist of an increased focus on creating a long-term vision, combined with stimulating learning and innovation. Incentive structures should match these long-term goals. The best way to go about this could be to start pragmatically by taking many small steps in the right direction, building more strongly on the innovative capacity of citizens and businesses worldwide. By exploring best practices, diffusing technologies and making incremental improvements, support and understanding may be created for the more radical changes that are required. Such an approach could be based on the following key elements:

1. Develop a consistent vision with long-term goals and short-term targets, integrating various areas of sustainable development;
2. Ensure that the rules and regulations which govern day-to-day decision-making are adapted to create the right incentive structure for transformative changes;
3. Increase coherence between relevant decision-making processes;
4. Reform policy-making at an international level.

These elements are explored further below. Clearly, there is a certain tension between the bold changes required to realise sustainable development and the pragmatic policy approach suggested above, the effectiveness of which is yet unknown. However, the current approach does not have the required track record. Given difficulties of agreeing, upfront and on the highest level, on a policy package, it seems important to consider alternative options that implement ambitious elements of a sustainable development trajectory, strengthen social and institutional learning and thus aim to avoid the costs of inaction.

Develop a consistent vision with long-term goals and short-term targets, integrating various areas of sustainable development
Currently, an overall vision on sustainable development is lacking. Although visions are sometimes regarded as soft tools, they may have a serious effect if they mark the clear choice for a sustainable future. Converging towards consensus at international and national levels on an overall vision may help to provide direction in policy-making. Such a vision would link sustainable development issues and involve formulating and agreeing on priorities for different types of countries.

One element here could be to agree on a set of sustainable development goals and targets. Past experience (e.g. the Millennium Development Goals (MDGs) and some environmental policies) has shown that goal-setting could aid effective decision-making. In a similar way, sustainable development goals could form a coherent framework highlighting sustainability issues. Possible targets may include food security, biodiversity conservation and sustainable use, access to modern energy, climate change, and air pollution control.

Formulating and developing these goals will require time and careful consideration. Scenario projections, such as those in this report, could provide useful insights to link long-term ambitions to meaningful values for these new Sustainable Development Goals. Any agreement on goals, however, can only be effective if the governance rules of the game are also changed.

Ensure that the rules and regulations which govern day-to-day decision-making are adapted to create the right incentive structure for transformative changes

Society has an enormous capacity for innovation and learning (in the report, this is referred to as the *energetic society*). It is important to channel this capacity towards sustainable development, by ensuring that sustainable development considerations become part of the day-to-day decision-making process. Our analysis also showed that there is no single and simple solution for the transformation; consequently, changing the incentive structures and allowing for flexibility in societal responses seems a more promising strategy than focusing on specific response options that would steer society along a single, preset path.

The following policy actions and instruments could change the current incentive structure (addressing several market and coordination failures):

- abolish perverse incentives (e.g. environmentally harmful subsidies);
- define natural resource access and tenure rights and ensure that green policies and investments also focus on poverty reduction;
- strengthen the capacity for institutional learning;
- introduce dynamic regulation, stimulating continuous improvement, reinforced by extensive public procurement commitments;
- include sustainable development goals in the indicators used to measure progress;
- include environmental factors in current pricing systems (e.g. green taxation and payments for ecosystem services);
- develop enabling infrastructure, such as smart grids and sustainable city design;
- strengthen monitoring and feedback mechanisms, such as smart metering.

Increase coherence between relevant decision-making processes

The challenges posed by sustainable development are not only influenced by specific environmental and development policies, but also by other policy areas, such as trade, finance and energy. Therefore, it is crucial to increase the coherence between policy domains, long- and short-term goals and levels of decision-making, all focused at sustainability as the overarching target. This would, for example, imply that sustainable development consequences are taken into account in energy security decisions.

For an increase in coherence, it is important to consider synergies and trade-offs. Some examples are:

- sustainable access to food, safe drinking water, and modern energy sources improves health and saves considerable time and effort in water and fuel collecting;

- sound ecosystem management results in cleaner drinking water, higher carbon uptakes and improved soil quality, sustaining a higher agricultural production;
- an integrated approach towards achieving climate, air pollution and energy security targets may lead to significant cost reductions;
- bio-energy can help to reach the climate goal, but complicates achieving those for biodiversity and food. Regulation and monitoring are needed to keep negative impacts within acceptable boundaries;
- certain air pollution measures may improve health, reduce climate change and prevent ecosystem damage.

Reform policy-making at an international level

Multilateral decision-making processes are needed to find effective and fair solutions. However, the current processes seem unable to stimulate the necessary transformative changes in time. As part of a pragmatic response, the focus could be on three complementary strategies. First, progress may result from new coalitions of the willing, consisting of both state and non-state actors, such as municipalities, businesses, NGOs and local citizen organisations. Through their cooperation, they could contribute to a scale up of local solutions. Second, sustainability actions could be reframed, finding new and more appealing concepts and narratives to mobilise citizens, businesses and governments around the world. Examples include concepts, such as the green economy, resource efficiency, energy security and human health. These framings are based on the aspirations, primary concerns and interests of societal actors. Third, institutions that deal with sustainability at international level could be reformed. This would include a strengthening of sustainable development within the United Nations, ensuring a better science–policy interface, and giving businesses and non-governmental organisations a stronger role within the international system.

1 Introduction

Today's challenges and the challenges that lie ahead ask for a more effective approach to sustainable development

In 1992, the world agreed to strive for sustainable development by adopting the Rio Declaration, Agenda 21 and the Rio-conventions. There is a general consensus that sustainable development is about improving human development (i.e. satisfying human needs and aspirations) while ensuring environmental sustainability (i.e. staying within the carrying capacity of the planet). Since 1992, the world has seen improvements in welfare, and reductions in both poverty and local environmental problems. However, in two priority areas – *food, land and biodiversity* and *energy and climate* – policies have not led to a reversal of historical, unsustainable trends. In this context, the main message of this report is that there is a clear need to strengthen current policy efforts and to search for more effective ways of sustainable development governance. There are four important reasons for this: 1) the slow progress, so far; 2) the changed geo-political, economic and societal context; 3) the expected consequences if current trends continue; and 4) the radical changes needed to achieve sustainable development goals. These factors will be explored further in the following sections.

Since 1992, the geo-political, economic and societal context has changed considerably

One reason for adapting the current governance approach is the changed geopolitical, economic and society context. In 1992, differences were clear between country groupings, in terms of economic developments and their contribution to environmental problems, and related to this, the responsibilities of these groups. However, economic and geopolitical developments since then have resulted in a far more diverging picture. This clearly has consequences for policy-making. Also, civil society has become much more actively involved in governance processes. An important factor here is that new media are able to spread information and opinions much more rapidly and effectively than ever before. The context has also changed due to the significant advancement of the science that underpins many sustainable development issues since 1992 (most noteworthy that of climate change). And then there are the current economic and financial crises, which imply that several countries may need to reconsider their economic model, while at the same time there are less public funds available for resolving sustainability problems. Finally, there is widespread concern about the political willingness and institutional capacity to build a strong multilateral system that is capable of dealing with sustainability problems.

This report explores the efforts needed to achieve a set of ambitious long-term sustainable development goals, consistent with existing international agreements

The main purpose of this report was to provide an assessment of the efforts needed to achieve a set of sustainable development goals. For this assessment, we used model-based scenario analysis as well as an analysis of governance issues to explore elements for a more effective governance approach. We looked into the question of how a set of

long-term sustainable development goals could be achieved. The set of sustainable development goals has been based, as much as possible, on the ambitions expressed in existing international agreements. For human development goals, we concentrated mostly on the development aspects that are directly related to the environment, that is, the access to natural resources and the influence of environmental factors on health.

The report focuses on two key clusters of sustainable development issues: 1) food, land and biodiversity loss, and 2) energy, air pollution and climate change

Several reports have studied the current situation with respect to environmental and development issues and possible future developments, including the Millennium Ecosystem Assessment (2005), the OECD Environmental Outlook to 2050 (2012) and the Global Environmental Outlook to 2030 (2007). From these reports, the conclusion can be drawn that two clusters of issues play a critical role in the sustainable development debate: 1) ensuring sufficient food supply while conserving biodiversity, and 2) ensuring a modern energy access for all while limiting global climate change and air pollution. This report elaborates pathways that will achieve sustainable development goals by 2050, for these key clusters. In addition, the impacts of reaching these goals on water use, nutrient balances and human health were analysed. Although the pathways share many common elements, they differ in the emphasis that they place on the role of global technologies, decentralised solutions and necessary consumption changes.

The analysis focused on the following questions:

- *What could be sustainable development goals for 2050, for energy, climate, food and biodiversity? (Section 2)*
- *What are the historical and expected future trends related to these goals? (Section 3)*
- *Which barriers have prevented goals from being achieved (Sections 3 and 4).*
- *Which efforts would be needed to bend current trends, in order to achieve the sustainable development goals? What are the key dilemmas, synergies and trade-offs with respect to this effort? (Section 4)*
- *Which policies are needed to achieve these goals and what are the consequences for governance? (Section 5)*

The analysis is intended to contribute to the development of a vision on sustainable development. The methodology applied is described in Box 1.

The report distinguishes between *objectives*, *goals* and *targets*. *Objectives* refer to visions, such as free people from poverty, halt biodiversity loss, and avoid dangerous anthropogenic interference with the climate system. *Goals* are more generic and often more long term, such as the 2 °C target (Copenhagen Agreement) and the ambition to eradicate poverty and hunger (Millennium Development Goal 1). *Targets*, finally, are more specific and short term, such as the Kyoto targets for the 2008–2012 period and the MDG target to halve, between 1990 and 2015, the proportion of people who suffer from hunger.

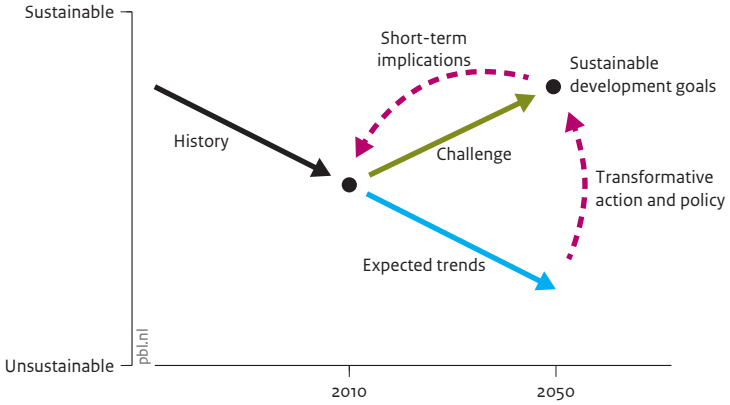
Box 1 Methodology applied in the report

The analysis is based on a model-based backcasting approach combined with analysis of governance issues

For this report, a backcasting approach was used, meaning that pathways were designed that would achieve the sustainability goals to explore the level of effort involved (taking into account technical feasibility constraints). Earlier assessments have focused specifically on separate issues (e.g. on climate), whereas, for this report, we considered the challenge of achieving a comprehensive set of goals, within the same time frame, for different issues. It is clear that there are important linkages between these issues; integrated assessment models can be used to explore these issues. We used the PBL integrated assessment model IMAGE in combination with related models for biodiversity, human health and climate policy (GLOBIO, GISMO and FAIR, respectively). These models provide a global overview, while differentiating between world regions. They have been used in many global and regional assessments, including for the IPCC, the OECD Environmental Outlooks, the UNEP's Global Environment Outlooks, and the Millennium Ecosystem Assessment.

Figure 1

Backcasting analysis, working back from a sustainable end point to determine actions for today



Source: PBL

Indicative representation of the analytical set up of this report. The Trend scenario depicts the possible trends in the absence of strengthened policies. The Challenge pathways explore how to achieve a set of sustainable development goals.

In total, four scenarios or pathways were analysed. The *Trend* scenario is designed to describe possible trends in the absence of strengthened policies. Three *Challenge* pathways were designed to achieve a comprehensive set of sustainability goals. The different measures (technology, consumption changes) included in these pathways and the policy instruments that could bring us from the *Trend* scenario to the *Challenge* pathways in order to achieve the goals are referred to as transformative action and policy. This approach is illustrated in Figure 1.

The scenario analysis concentrates on the physical changes required to achieve a particular set of sustainability goals. The models took into account, as much as was possible, the limitations in terms of physical and economic feasibility (e.g. potential for improving yields and the capital turnover rate in the energy system). Political and societal feasibility (i.e. whether such changes could actually be implemented based on an assessment of the current political situation) were not accounted for in the scenario analysis. Instead, we used the scenario outcomes to assess some of the policy consequences.

2 Long-term vision and goals for food, biodiversity, energy and climate

It is important to develop a consistent vision with long-term goals and short-term targets that integrate different sustainable development themes
At the moment, an overall vision on sustainable development seems to be lacking. The formulation of goals and targets in various agreements is often unrelated, uses different time frames, is based on different degrees of concreteness, and are sometimes even missing. Given the large number of interactions between various sustainable development issues, a clearer vision on sustainable development, including long-term goals and short-term targets could be an important building block for a worldwide effort on sustainable development. Such an approach has shown to be effective for the Millennium Development Goals (MDGs), and, in preparation of the Rio+20 conference, proposals have been made to take a similar approach for sustainable development.

In our analyses of the pathways to achieve a set of environmental and development goals and targets, wherever possible, we derived these goals and targets from international agreements. In some cases, these agreements include formulations of quantifiable targets. In other cases, we interpreted existing qualitative formulations based on the scientific literature. The selected goals are summarised in Box 2.

For *human development*, international agreements have mostly concentrated on minimum conditions for a decent life for each individual. The main overarching international agreement is that of the Millennium Development Goals (MDGs). For the *environmental dimension*, a large number of international agreements have been formulated to prevent further degradation or even reverse the historical processes. The most relevant agreements to our analysis were the UN Framework Convention on Climate Change (UNFCCC) and the Convention on Biodiversity (CBD).

Box 2 The development and environmental goals analysed in this study

The sustainable development goals analysed in this study were derived from existing agreements. The goals explored in this report are those related to the principles of the Rio declaration, in particular Principle 5 (eradicate poverty) and Principle 6 (conserve the Earth's ecosystem).

Goals for food, land and biodiversity loss:

- Halve, between 1990 and 2015 , the proportion of people who suffer from hunger; halve this again by 2030, and fully eradicate hunger by 2050;
- Halve the rate of loss of biodiversity by 2020 and maintain biodiversity at the 2020/2030 level by 2050 (depending on region).

Goals for energy, air pollution and climate:

- Achieve universal access to electricity and modern cooking fuels by 2030;
- Avoid temperature increases above 2 °C keep atmospheric greenhouse gas concentrations below 450 ppm CO_2 equivalent;
- Keep annual $PM_{2.5}$ concentrations below 35 µg/m³ by 2030.

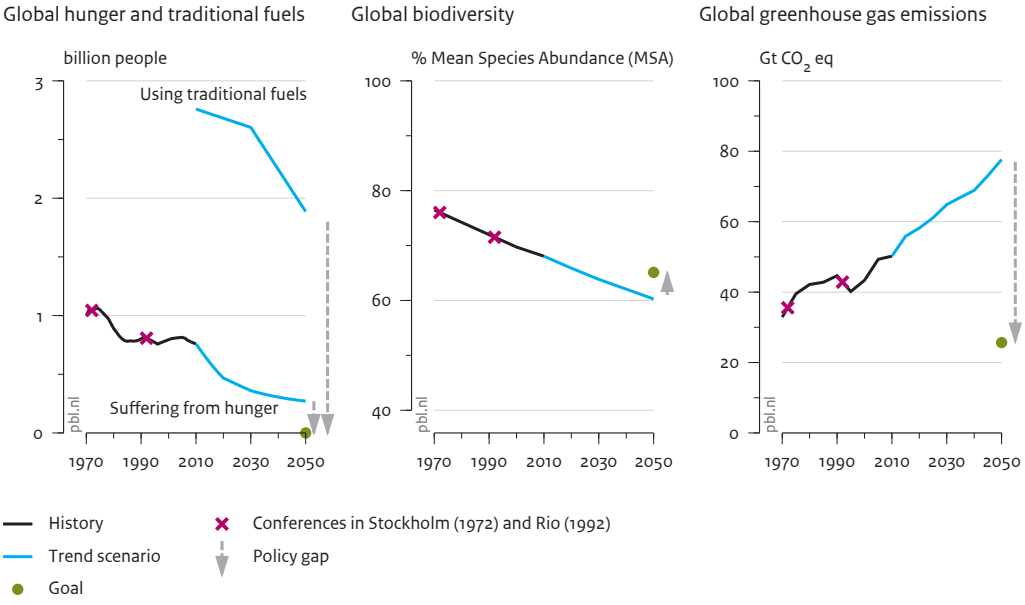
3 What are the historical and expected future trends related to sustainable development goals?

Although the outcomes of the UNCED conference have been the basis for many activities aiming towards more sustainable development, these have not been able to bend the trend in some critical areas of sustainable development

The 1972 Stockholm Conference and the 1992 Rio Conference have led to many new institutional arrangements and activities aimed at achieving a more sustainable development. In some areas, also clear progress has been made, such as reducing absolute poverty and improving access to safe drinking water; as both MDG targets are likely to be achieved by 2015. In other, critical areas of sustainable development actions have not been able to bend the trend, such as for providing access to sufficient food and

Figure 2

Key indicators of sustainability in the Trend scenario



Source: PBL

Historical and projected trend for key indicators, in a situation without new policies. The sustainable development goals analysed in this study and the policy gap are also indicated. There are various indicators for biodiversity. Here, we use MSA (mean species abundance). This indicator is related to naturalness.

modern forms of energy, preventing dangerous climate change, conserving biodiversity and controlling air pollution. Figure 2 shows this for a number of key indicators addressed in this report:

- *Number of people suffering from hunger*: the absolute number of people suffering from hunger has remained almost constant since 1992. While some progress was made to reduce hunger up to the mid-2000s, increasing food prices have led to more people without sufficient access to food, especially in sub-Saharan Africa and South Asia.
- *Access to modern energy*: almost one billion people currently have no access to electricity and almost three billion people still use solid fuels for heating and cooking. This has clear negative impacts on human health and development prospects.
- *Decline in biodiversity*: biodiversity, as measured in mean species abundance (MSA)[1], has continuously declined since 1992, mostly due to habitat loss, but also to increasing environmental pressures and disturbance. The extent of natural area decreased by some 4.6 million km² since 1970.

- *Climate change*: greenhouse gas emissions increased by around 30% over the 1992–2010 period.
- *Air pollution* (not shown): Although air pollution was reduced in OECD countries and some developing countries, it has increased in the cities of many other developing countries.

Several barriers have prevented sustainable development targets from being achieved

A number of generic barriers are mentioned in the literature, which, together, could explain why current sustainable development goals have not been achieved:

- *Short-term interests* tend to be *prioritised over long-term concerns*.
- There are many different interests; some actors will win and others will lose in the transition towards sustainable development. *Vested interests cause resistance to the required changes*.
- *Lack of connection between the environment and development.* Energy and land-use policy-making is often *fragmented* and sustainable development concerns are often not integrated into processes of general, economic decision-making (mainstreaming).
- This problem is amplified because of the *lack of a strong institutional framework* to handle global problems at international level.
- *Incentive structures are not conducive to sustainable development.* Current economic incentives often award private benefits at the cost of public interests. Incorporation of environmental and social costs is lacking in many areas.
- The *inability to address absolute poverty, especially in Africa*, is also visible in the insufficient progress made with respect to ensuring access to modern energy and food security.

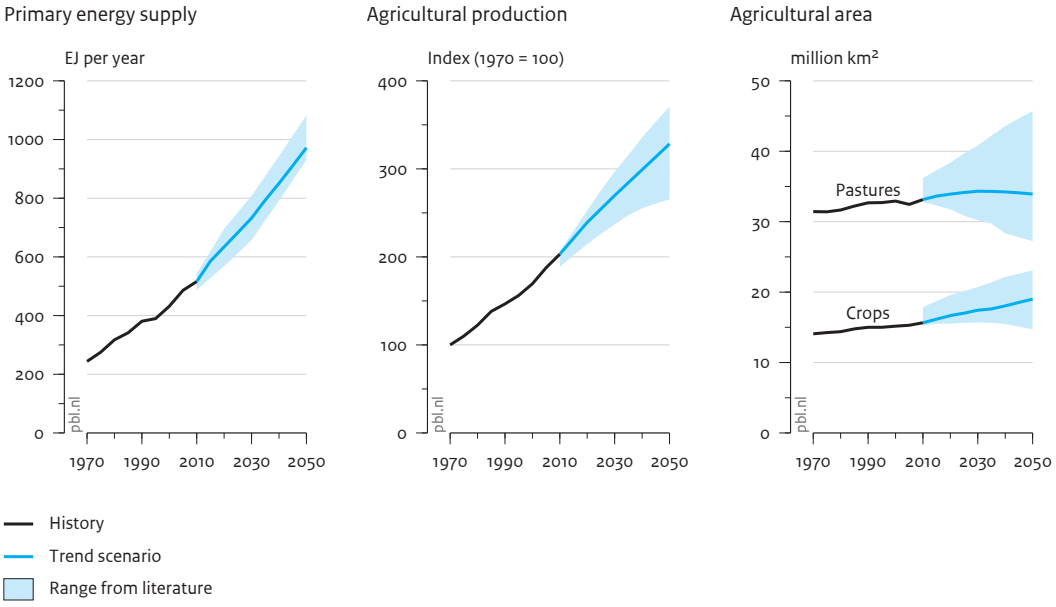
Population and income growth are projected to lead to strong growth in the demand for food and energy by 2050

In the *Trend* scenario, the world population is projected to continue to grow from around 7 billion people in 2010 to 9 billion by 2050. This growth mostly occurs in sub-Saharan Africa and South Asia. At the same time, economic projection (based on the OECD Environmental Outlook to 2050 (2012)) shows a further increase in per-capita GDP in all world regions. Most economic growth is expected in developing countries. Towards 2040, the highest growth rates are projected for Asia. After 2040, the highest per capita growth rates are projected for Africa, although it will remain the continent with the lowest per capita income levels.

As a consequence of these trends, a strong increase in the demand for energy and agricultural products and related land use is projected (Figure 3). Figure 4 shows in more detail how the demand for agricultural products is driven by both population and income growth (they carry a more or less equal weight over the 2010–2050 period). In agriculture, historically, most of the additional demand was met through an increase in productivity per hectare; about 20% of the increase in agricultural production was generated by expanding the total agricultural area. This practice is expected to continue, leading to some further expansion of agricultural areas (in particular for crops)

Figure 3

Global energy supply, agricultural production and agricultural area in the Trend scenario



Source: PBL/LEI

Energy production, food production and agricultural area, under the Trend scenario. The blue areas indicate the range of projections in the literature.

and to a further loss of natural areas. Nevertheless, as global population growth will slow down around 2050, global land-use expansion is projected to stabilise near the end of the scenario period. Energy demand is expected to grow by 60% to 80% over the 2010–2050 period, with few signs of stabilisation. Most of the demand under this scenario is expected to be met by fossil fuels.

The sustainable development goals will not be achieved under the *Trend* scenario

In the *Trend* scenario, the following developments are foreseen with respect to the sustainable development goals (Figure 2):

- As far as global hunger is concerned, the *Trend* scenario shows some clear improvement, in contrast to the last few decades. This improvement is a consequence of a rapid income growth in low-income regions and levelling-off of population growth.
- For biodiversity, a further decline is projected – at an almost linear rate. Although, historically, habitat loss has been the most important driver of biodiversity loss, for the future, climate change, forestry and infrastructure development are projected to become important factors, as well.

- Greenhouse gas emissions are projected to grow by another 60%. Global mean temperature, therefore, is projected to surpass the 2 °C goal well before 2050 and to continue to rapidly increase. By the end of the century, a global mean temperature increase of more than 4 °C is then likely.
- Access to modern energy sources is projected to improve, largely driven by the relatively high economic growth in developing countries. However, due to population growth, persistent poverty and inequality, and increasing energy prices, around two billion people will still rely on solid fuels for heating and cooking by 2050.
- Finally, air pollution levels are expected to decrease in high-income countries, in line with the historical trend. In most developing countries, however, increasing energy production is projected to be associated with more air pollution.

Many of the developments depicted above will lead to considerable costs. Persistent hunger and lack of access to modern energy sources imply that the development opportunities for a large number of people would still be seriously hampered. Further degradation of ecosystems will also come at a cost. For instance, climate change could lead to considerable costs related to sea level rise, crop yield decreases and higher risks of extreme weather events. Air pollution will lead to costs in terms of health damage and reduced crop growth. Biodiversity loss, in turn, is shown to negatively affect ecological goods and services.

4 Which efforts would be needed to bend current trends, in order to achieve the sustainable development goals?

Three alternative pathways that combine different assumptions on the use of technology and consumption changes were used to explore how sustainable development goals could be achieved

We do not imply that these are the preferred development trajectories, nor that they are the only pathways possible. The pathways differ in their emphasis on changing consumption patterns, the role of large-scale technology and the focus on global versus local approaches.

Table 1
Characterisation of analysed pathways

Pathway	Main assumption
Global Technology	Achieves the 2050 targets, with a focus on large-scale technologically optimal solutions, such as intensive agriculture and a high level of international coordination; for instance, though trade liberalisation
Decentralised Solutions	Achieves the 2050 targets, with a focus on decentralised solutions, such as local energy production, agriculture that is interwoven with natural corridors and national policies that regulate equitable access to food
Consumption Change	Achieves the 2050 targets, with a focus on changes in human consumption patterns, most notably by limiting meat intake per capita, by ambitious efforts to reduce waste in the agricultural production chain and through the choice of a less energy-intensive lifestyle

4.1 Food, land use and biodiversity

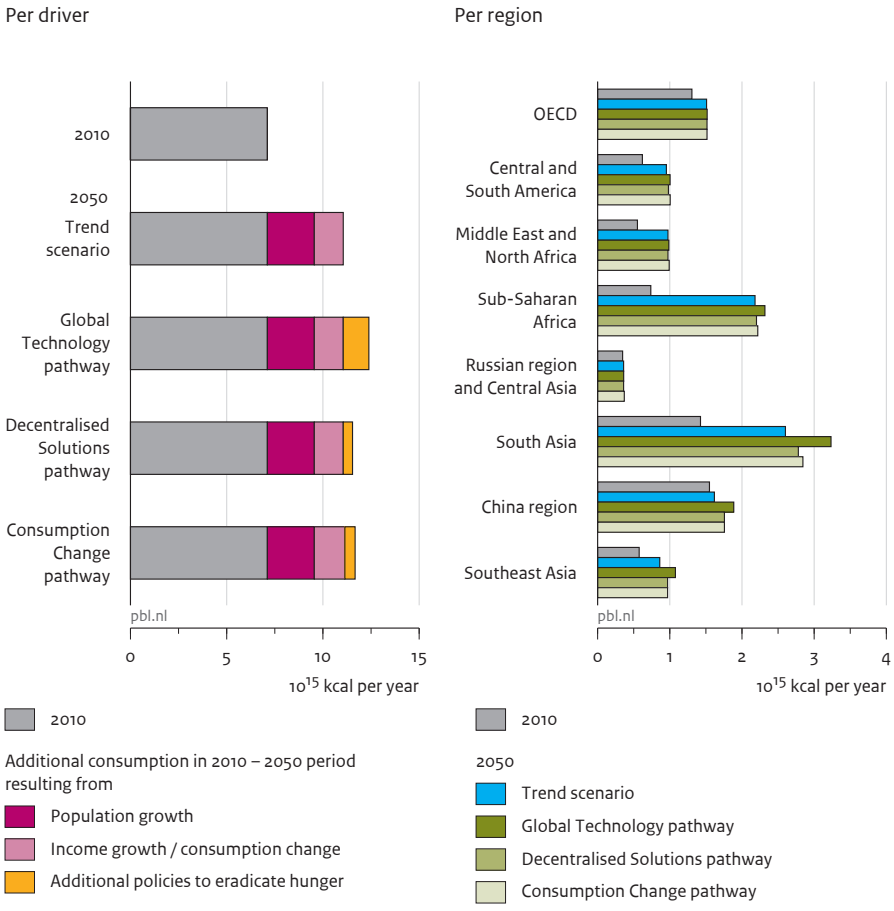
Fundamental policy issues need to be addressed, in the coming decade, to ensure progress in achieving the sustainable development goals related to food, land use and biodiversity

One overarching goal can be formulated with respect to the biodiversity and food cluster: eradicate hunger and maintain a stable and sufficient food production by 2050 while conserving biodiversity and ecosystems. The analysed biodiversity target was derived from the CBD's long-term vision to *conserve, value, restore and wisely use biodiversity*. The target to eradicate hunger was derived from MDG1 and extrapolated to 2050.

Several trends influence the efforts to reach these goals. With an estimated 925 million people undernourished in 2010, food insecurity continues to hamper development and keeps people trapped in poverty. The ambition to improve their circumstances, however, has to be realised against a backdrop of an increasing demand for food, feed and fuels, which requires agricultural production to increase by 60% to 70% in less than four decades. Over the last decade, however, we have seen a slowdown in the growth in agricultural productivity and climate change is expected to negatively affect crop production in tropical regions. These factors, together, are likely to lead to an increase in competing land claims, which, in turn, could lead to higher and more volatile food prices and loss of biodiversity. In addition, increasing fragmentation, pollution and climate change also will lead to the degradation and loss of ecosystem services.

Over the last decades, several barriers have slowed down progress towards achieving sustainable development goals, in particular: 1) persistent low incomes limit access to food, certainly if higher and more volatile food prices become a new reality; 2) many smallholder farmers have limited opportunities to increase production; 3) low levels of public investment in agricultural research and development; 4) natural capital and ecological goods and services are undervalued in public policy and planning; 5) a lack of consideration for biodiversity concerns in other policy areas; and 6) many countries

Figure 4
Global calorie consumption



Source: PBL/LEI

The lion's share of the growth in food demand until 2050 will be driven by population and income growth in developing countries. The pathways differ in total caloric consumption, based on assumptions on how to ensure access to food for the poor, on reducing waste within the food chain, and on dietary change.

have a limited financial, technical and administrative capacity to manage natural capital. These need to be addressed if sustainable development goals are to be achieved.

The additional amount of food required to eradicate hunger is only small, compared to the autonomous growth in demand

Figure 4 shows the total caloric consumption level in each region, as well as the relative importance of the drivers of increased demand; that is, population growth and income growth leading to dietary changes. Ensuring that the food system will be able to supply

this additional demand presents a formidable challenge, and most of this additional demand will be in developing regions. The sustainable development goal adopted in the pathways is that of eradicating hunger by 2050 through different combinations of global or local agricultural production increases and more equitable access to food (representing national policies targeting the poorest groups within society). Compared to total production levels, this additional amount of food to eradicate hunger is only small. In other words, providing full access to food does not need to represent a serious trade-off with the conservation of habitats and biodiversity.

Each pathway would prevent over half of the projected future biodiversity loss and would stabilise the extent of natural areas, but differ fundamentally in their approach

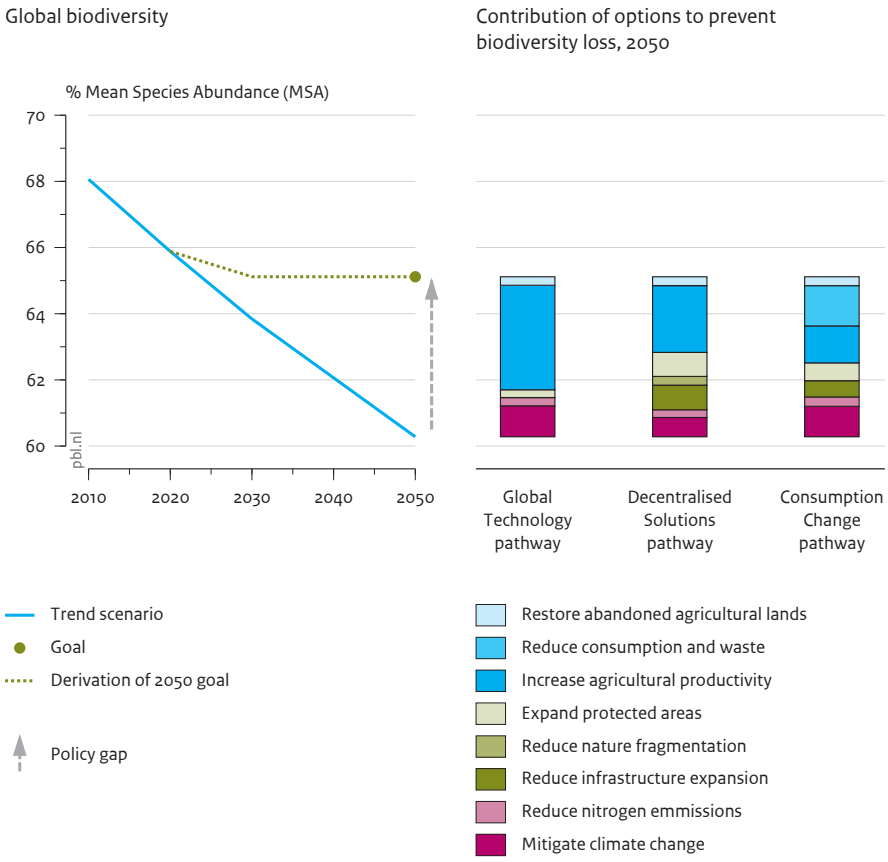
There is a significant loss of biodiversity projected under the *Trend* scenario up to 2050. The pathways all show that it would be possible to arrive at the 2050 biodiversity target, which was set at the biodiversity level of 2020/2030 of the *Trend* scenario (Figure 5). In fact, this would imply that the net extent of natural area would be maintained at the 2010 level. However, the three pathways use very different combinations of measures to achieve this goal. Under the *Global Technology* pathway the most important contribution by far comes from increasing agricultural productivity on highly productive lands. Under the *Consumption Change* pathway, significant reduction in the consumption of meat and eggs as well as reduced wastage means that less agricultural production would be required, thus, reducing the associated biodiversity loss. Under the *Decentralised Solutions* pathway, a major contribution would come from avoided fragmentation, more ecological farming and reduced infrastructure expansion. Under all scenarios, climate change mitigation, the expansion of protected areas and the recovery of abandoned lands also significantly contribute to reducing biodiversity loss.

All pathways require a substantial increase in agricultural productivity to ensure that sustainable development goals are achieved

Under the *Trend* scenario, the annual growth in agricultural productivity is projected to decline further in line with the trend over the past 15 years (see Figure 6 for cereals). An important reason for this fact is that, in different parts of the world, yields are getting closer to potential maximum achievable levels; the easiest measures have already been implemented and public investment in agricultural research and development has been slowing down, in relative terms. In the pathways, however, a much higher productivity growth would be needed to achieve the goals. The required increase in productivity would be the highest under the *Global Technology pathway*, which is twice that of the *Trend* scenario (1.3% annual increase versus 0.6%). In the other two pathways, however, productivity improvements would also need to be above the *Trend* scenario level. Analysis has shown that several technological options exist for increasing yields sustainably, could be applied in the various farming systems around the globe. The relatively low yields achieved in some developing countries, in particular in sub-Saharan Africa, provide significant potential for improvement, although, to date, socio-economic

Figure 5

Global biodiversity and options to prevent biodiversity loss



Source: PBL

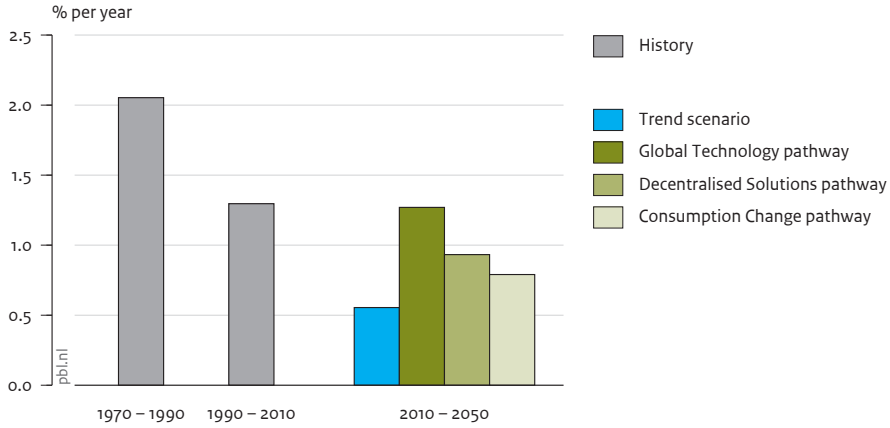
There is a range of options available to achieve the goal on biodiversity. The three pathways each have a different emphasis, but all make clear that global biodiversity conservation requires efforts on many fronts.

factors have acted as barriers, in this respect. Clearly, a massive effort would be needed to improve yields in developing and developed countries.

The consumption of fewer animal products and reductions in food losses would considerably reduce the need to increase yields

The *Consumption Change* pathway shows that not only technical measures may help to ensure the achievement of sustainable development goals; limiting consumption of meat and dairy products and reducing food losses would also be especially effective for achieving the goals. The production of livestock products demands large tracts of land

Figure 6
Increase in global cereal productivity



Source: PBL / LEI

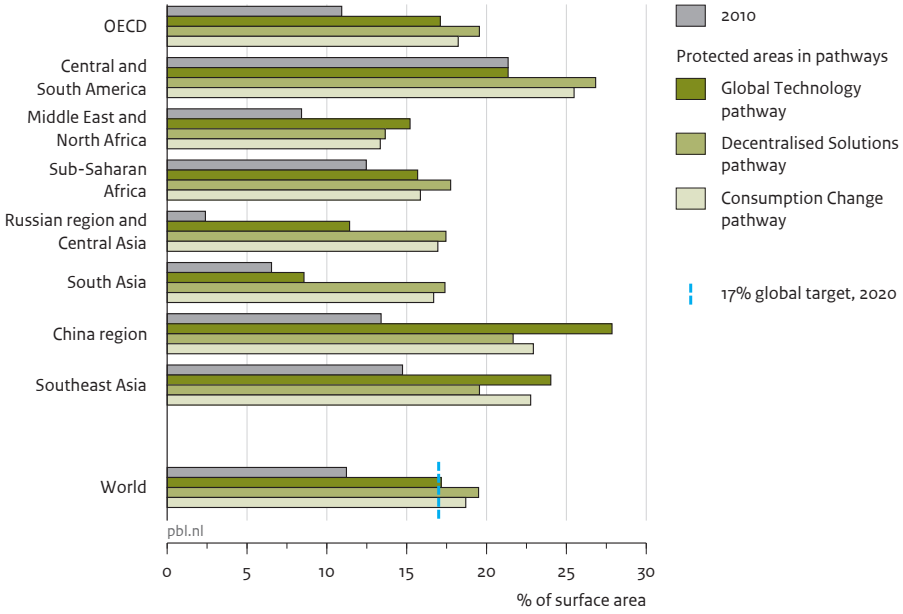
The Trend *scenario projects the decreasing trend of cereal productivity growth to continue. In the pathways, a reversal would be needed in order to satisfy increased demand and limit expansion of agriculture area.*

for grazing and feed production, because of the inefficiencies in converting feed into meat and dairy produce. Moreover, estimated food losses stand at one-third of agricultural production.

Mono-functional and multifunctional landscapes both have significant scope for increased and more sustainable production, but require improved land-use planning for optimal use

Multifunctional landscapes may offer areas of agriculture that are highly interwoven with nature areas, improving local ecosystems and connectivity between natural areas. It is likely that such an approach would lead to somewhat lower production intensities compared to mono-functional landscapes. Mono-functional landscapes, however, may lead to more local biodiversity loss. Clearly, both systems have considerable scope for a more sustainable and higher productivity. In mono-functional landscapes, low external environmental impacts may be achieved by a strong emphasis on resource efficiency using cutting edge technological refinements, agronomic optimisation of the farm environment and new animal breeds and crop varieties that perform best under these optimised conditions. In multifunctional landscapes, high yields may be achieved by combining technological advances with the services provided by natural processes. The differences between these systems may become smaller due to the current direction of agricultural research, allowing for improved production in agro-ecological systems and reduced impacts in intensive systems.

Figure 7
Globally protected areas per region



Source: PBL

The pathways employ different rules to allocate new areas to be protected – effectively protecting 17% of the global terrestrial area.

International cooperation on protected areas will be needed

Biodiversity hotspots and other protection targets are often unevenly distributed across the different continents. In the pathways, we assumed different allocation schemes to protect on average 17% of the terrestrial areas. Still, in all pathways, Central and South America, China and Southeast Asia would be required to protect more than 17%, due to the ecological value of their ecosystems (Figure 7). Especially in developing regions, establishing effective protection in current and future protected areas is challenging. Internationally, however, costs would seem to be modest, especially considering the benefits that protected areas may bring; for instance, via ecosystem service management and tourism. Mechanisms to facilitate and scale up international financing of protected areas are essential.

Box 3 Key issues for the coming ten years to eradicate hunger and maintain a stable and sufficient food production by 2050 while limiting biodiversity loss

Accelerate the sustainable intensification of agriculture
As shown, relatively high rates of agricultural productivity improvement would be required during the 2010–2050 period. Improvement rates would need to be scaled up in the near future, in order to avoid requiring even higher improvement rates in the more distant future. Most of the technologies required for sustainable intensification are already being used by best performers or are in an advanced stage of development. Scaling up these improvements is key. A first step would be to better enable farmers to make long-term investments; for instance, by improving market transparency, price stability and secure land tenure. Concurrent action will be needed to address externalities; for example, by removing distorting subsidies, implementing regulation to discourage land conversion and/or creating income opportunities from preserving nature and ecosystem goods and services. Reversing the trend in public investment in agricultural research and development, particularly in developing countries, is also a priority.

Create a more robust food system
The effects of extreme or unexpected food price volatility on farmers and consumers can be mitigated by improved stock management, creating more transparent and well-functioning market mechanisms and investing in more climate-resilient agricultural systems. Putting domestic safety nets in place to mitigate the impacts of high and volatile prices on the poorest consumers is also important. Another important measure is to monitor the land used for bio-energy and to act in case of excessive land claims.

Integrate biodiversity and ecosystem services into land-use planning and management
Integrated land-use planning requires the ability to assess the different demands and uses for land, and to have the administrative capacity to translate these into policies and action on the ground. For this to work, financial, technical and administrative capacities must be developed. The consideration of ecosystem services in land-use planning could lead to better-informed decisions and more optimal allocation of land to different uses.

Initiate a shift towards alternative consumption patterns
Reducing the consumption of animal products emerges as a robust measure to mitigate climate change and limit biodiversity loss. This would imply a more forceful steering of consumption patterns. Potential instruments include regulation, economic incentives, and information campaigns. It might be that a focus on health benefits of reduced meat consumption could be the best avenue to initiate a shift towards alternative consumption patterns.

4.2 Energy and climate

Key challenges in the energy sector include: provide sufficient energy for the rapidly increasing global demand for energy services, ensure access to modern energy for all, reduce the environmental impacts of the energy system and improve energy security

This report concentrates specifically on the question of how to provide access to modern energy for all, while substantially reducing greenhouse gas emissions as well as air pollution. Historically, there have been several barriers that have slowed down progress in responding to energy challenges. In addition to the generic barriers mentioned in Section 3, the following extra barriers apply: 1) pervasive doubt about the extent and seriousness of climate change; 2) large and conflicting interests in the energy system; 3) lock-in dynamics and subsidising of fossil fuels; 4) uncertainty regarding energy prices; 5) a bias towards supply-side investments over those on the demand side; and 6) a lack of commitment to address the energy needs of the poorest segments of the population.

Universal access to electricity and clean fuels for cooking and heating has large development benefits and can be achieved at relatively low costs

Analysis has shown that ensuring access to modern energy sources for heating and cooking as well as electricity may lead to multiple benefits. It reduces health damages from air pollution, improves development opportunities through electrification and a reduction in the time spent collecting firewood, and decreases deforestation. However, a large number of people still have only limited access to modern energy. Despite some level of improvement, under the *Trend* scenario, for one to two billion people a lack of such access is projected to continue.

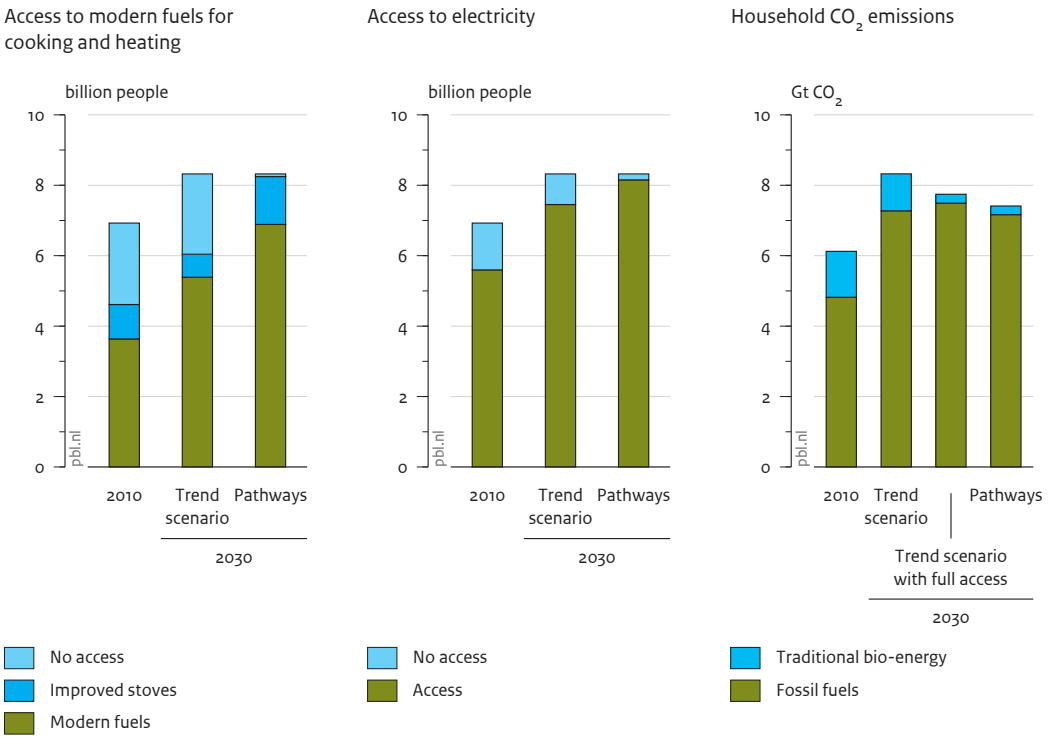
Our analysis shows that it is possible to increase access to modern fuels for cooking and heating through well-targeted subsidies of cleaner fuels, such as LPG and kerosene, combined with grants or micro-lending facilities to improve the affordability of the required stoves (Figure 8). Additional programmes are likely to be needed in areas where poverty remains high, such as the distribution of improved biomass-fuelled cooking stoves. These stoves are more efficient and less polluting than conventional ones. Improving access to electricity requires a combination of grid expansion, decentralised mini-grids and off-grid systems. The cost of achieving universal access to modern energy sources is estimated at around USD 70 billion, for the 2010–2030 period. The economic benefits of improving health and providing development opportunities are likely to far outweigh these costs.

Ensuring universal access to modern energy leads to only a small increase in fossil-fuel related greenhouse gas emissions, and, overall, may even lead to a decrease

One of the main results from our analysis consists of the indication that providing access to modern energy sources would only have a small impact on greenhouse gas emission levels, even if the programme would focus on providing fossil fuels (in order to limit

Figure 8

Global household access to modern fuels and CO_2 emissions



Source: PBL

Providing access to modern energy would lead to only a small increase in fossil-fuel-related emissions and, overall, possibly even a decrease. Here, it is assumed that traditional bio-energy is not fully carbon-neutral.

costs). The net result may even be a reduction in greenhouse gas emissions. The reasons are that the per capita energy consumption of the people involved would (initially) be low. In addition, the same energy services could be provided much more efficiently when using modern fuels. Moreover, by increasing modern energy use, the emissions associated with the traditional use of biofuels would be reduced, including CO_2 emissions from deforestation and black carbon emissions from poor combustion. In other words, providing access to modern energy and climate mitigation do not necessarily present a trade-off. However, one should note that climate policies that increase fossil-fuel prices could potentially make the transition to modern energy sources and services more difficult; climate policy should thus be designed in a way that negative impacts on poor households are avoided.

Achieving air pollution and especially climate targets would require fundamental changes to the energy sector, compared with current trends

Greenhouse gas emissions are projected to grow by 60% under the *Trend* scenario. However, to reach the 2 °C target, global emissions would need to be reduced by around 40% to 50 % by 2050. Various pathways for such a transition have been published in the literature, each with a different emphasis on technologies and behavioural changes. One way to illustrate the fundamental shift is to use the decarbonisation rate of the global economy (Figure 9). This is the reduction in the ratio between CO_2 emissions and GDP. Historically, the highest improvement (over a five-year period) occurred during the 1980s at around 2% annually, driven by the high energy prices of the late 1970s and early 1980s and subsequent government response programmes. Under the *Trend* scenario, the historical annual rate of 1% to 2% is projected to continue. To achieve the 2 °C target, however, the decarbonisation rate would need to reach a level of around 4.5%, on average, over the 2010–2050 period. In the pathways, this rate is projected to slowly increase from 2010 onwards, based on all kinds of inertia, and implies an annual improvement rate of 5% to 6% around 2030. Rapid reductions would also be required to avoid overshooting the 2 °C target. After 2030, emission reduction could slow down somewhat, given the dynamics of the climate system and the depletion of low-cost mitigation options. The required improvement rate of 4.5% to 6 % is around three to four times the historical rate.

Energy efficiency improvement and decarbonisation of the energy supply both play a major role in reducing emissions

Decarbonisation may be achieved both through energy-efficiency improvements and rapid changes on the supply side. The change over time, for these factors, is shown in the right panel in Figure 9. As shown in various studies, it would be technically possible to reach such decarbonisation rates. However, it remains debatable whether this would still be possible if other factors are accounted for, such as societal inertia and the time it would take to govern this transition. Some key energy technologies have experienced rapid expansion in the past, such as natural gas infrastructure in some countries during the 1960s and 1970s, and, more recently, the use of combined cycle technology in the power sector. However, clearly, such rates are only possible if supported by focused government programmes and sufficient societal backing.

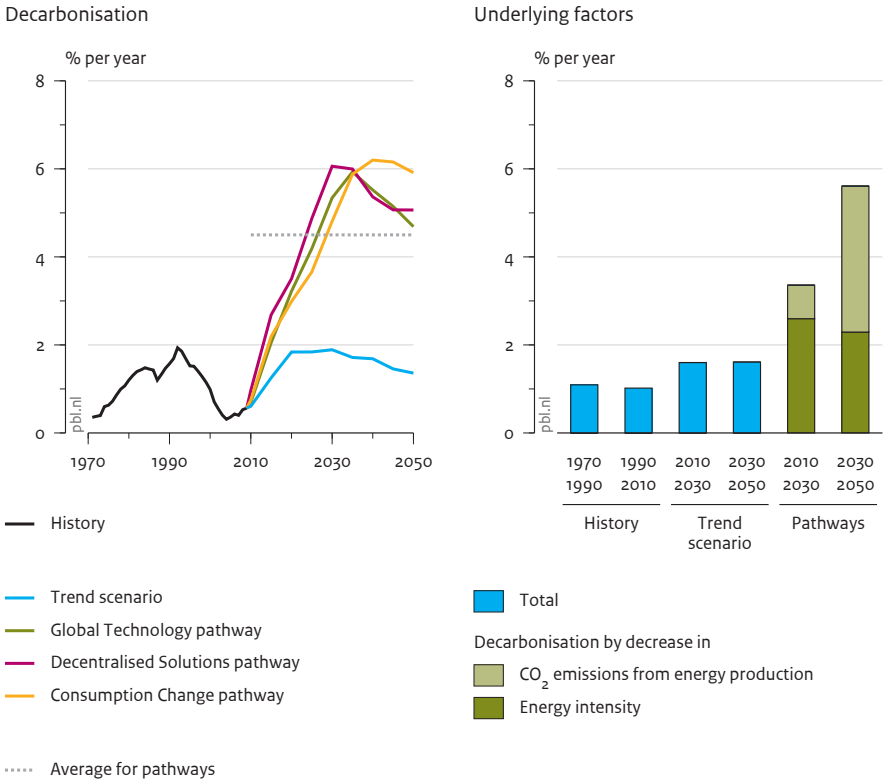
The energy transition would rely on several technologies. The changes required in the energy system are fundamentally different from current trends

Figure 10 shows how different mitigation measures contribute to the emission reductions required to achieve the 2 °C target. Table 2 summarises the consequences for the energy system in terms of key technologies in energy supply, both on the basis of the pathways of this report and of existing literature. Some important measures are discussed below.

Reducing other greenhouse gases, such as cutting gas flaring and industrial N_2O emissions and the recovery of CH_4 from landfills, are relatively inexpensive. An important

Figure 9

Global decarbonisation rate



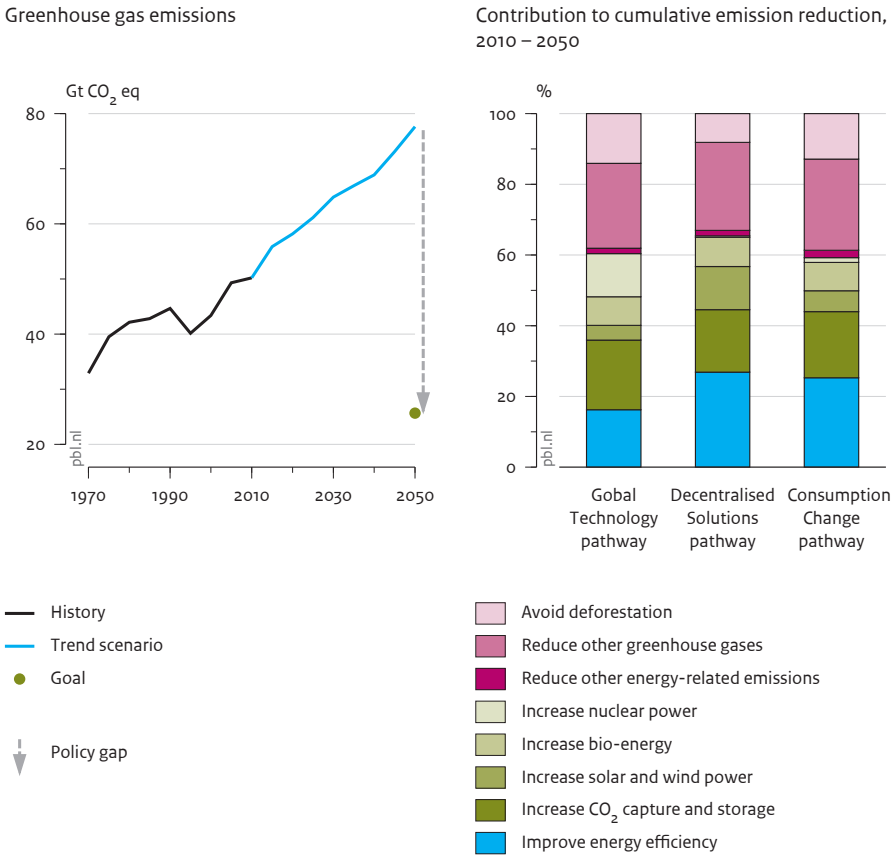
Source: PBL

Under the Challenge pathways, improvement of the carbon intensity would need to be considerably higher than the historical level.

consideration with respect to some non-CO_2 gases are the co-benefits: reducing CH_4 and black carbon emissions would lead to relatively quick gains for climate change and immediate gains in reducing ozone levels and avoiding damage to human health. It should be noted, however, that the potential for reductions in non-CO_2 greenhouse gas emissions is only limited, as emissions from some sources are very difficult to reduce to zero (e.g. N_2O emissions from fertiliser use and CH_4 emissions from ruminant livestock). *Energy efficiency improvements* play a key role. In fact, to reach the targets, energy-efficiency improvements need to occur at double the historical rate. There is considerable scope within the building, transport and industrial sectors, although progress in this area has proven to be difficult in the past. However, there is evidence of standards (e.g. related to appliances or construction) and financial instruments (also to

Figure 10

Global greenhouse gas emissions and options to reduce emissions



Source: PBL

Contribution of different mitigation measures to reductions in greenhouse gas emissions, in the different pathways (note that, although the pathways in this report all use carbon capture and storage, the literature also provides scenarios with less CCS use).

address possible rebound effects) being effective in this field. Potential exists in various sectors. For instance, some improvements could be made in transport by increased efficiency. Many more reductions, however, may be achieved through further electrification or the introduction of hydrogen vehicles, allowing the sector to benefit from the ability to produce electricity and hydrogen, using low- and zero-carbon technologies. In the building sector, considerable potential exists for achieving rapid improvements in the thermal integrity of buildings, by establishing standards for new construction and retrofitting, along with improved appliances and innovative business

Table 2
Share of different technology categories, trend versus alternative pathways

	2000	2050							
		Trend			Alternative pathways				
		This report	EMF22		This report			EMF22	
			Avg	Range	GT	CC	DS	Avg	Range
Fossil fuel	81	80	79	[68–95]	40	42	40	35	[13–48]
Fossil fuel +CCS	0	0	0	[0–0]	12	20	17	20	[0–31]
Bio-energy	9	6	9	[0–13]	13	14	16	15	[0–28]
Nuclear energy	6	4	3	[1–6]	22	6	2	14	[3–37]
Other renewables	5	10	9	[2–14]	14	18	25	16	[8–24]

Source: PBL/EMF22

NB: GT, CC and DS represent the three pathways considered in this report (Global Technology, Consumption Change and Decentralised Solutions). For comparison, the results from a model comparison study (EMF22) are added for both the Trend scenario and a 2 °C scenario.

models (e.g. energy service companies). Finally, in the industrial sector, energy demand may be reduced, substantially, by the widespread adoption of the best available technology, the retrofit of existing plants, optimisation of material flows and increased recycling.

On the supply side, *low- and zero-carbon energy* would need to provide 50% to 90% of the world's primary energy by 2050 (see Table 2). This could be in the form of non-combustible renewables, bio-energy, carbon capture and storage (CCS) and/or nuclear energy. Many of these options come with their own challenges with respect to implementation and/or sustainability issues, as for bio-energy. In any case, their implementation would require the further development of storage, conversion and end-use technologies and infrastructures, such as smart grids and super grids, and, in general, the rapid decarbonisation of energy systems. It is most likely that financial instruments – such as emission trading schemes, taxation and, first and foremost, the removal of subsidies on fossil fuels – could be successful to stimulate a transition. In addition, governments could also consider specific policies that aim to decrease the costs of clean-energy technologies (risking temporary additional costs).

The transition towards a low-carbon economy will require substantial investments. This could be especially challenging in developing countries

Estimates of the required level of investment in the energy system, over the 2010–2050 period, are substantial, even without a transition towards a more sustainable energy

Box 4 Key policy actions within the next 10 years

Modern fuels need to be made accessible and affordable to achieve universal access
The most important barrier to access is a lack of financing. Well-designed subsidy schemes for clean fuels for poor customers have proven to be successful. However, once incomes reach the level on which households will have the ability to pay, these subsidies need to be phased out.

For the 2 °C target, global emissions need to peak within the next 10 years
Scenario analyses tend to show that emissions need to peak soon, in order not to overshoot the emission budget consistent with the 2 °C target. Further delays could make climate policy very costly. In this context, government should consider phasing out the construction of coal power plants that do not use CCS, before 2020. This situation may be achieved through appropriate pricing, but also through more direct government policies aimed towards utilities.

For international climate policy, seek progress based on pragmatic approaches
It seems attractive to seek progress along different strategies (see also Section 5.4). Develop a consistent multilateral framework that supports energy transition if possible, but also work along alternative strategies that are based on the identification of co-benefits and the connection of 'coalitions of the willing' for energy transition. Clear long-term targets form part of such an approach.

Remove current national energy policy inconsistencies
Energy policies address a large number of different targets, both short term and long term. In order to meet long-term targets, it is important that these are also considered in short-term decisions. For instance, although constructing coal-fired power plants might be the cheapest option to respond to energy security risks, taking a higher cost solution that is more consistent with the long-term targets could in the end be more cost-efficient.

Consider policies that address energy-intensive consumption patterns
The analysis shows that consumer changes may help to ensure sustainability goals are achieved. It is important to stimulate the debate on less energy-intensive consumption patterns, but also to use financial instruments, such as a carbon tax to promote energy efficiency.

Arrange public and private financing for energy transition infrastructures
Ensure that public money is set aside for infrastructures for new energy technologies and for infrastructures that provide access to energy for the poorest people in developing countries. Seek cooperation with business where possible and appropriate; for example, to blend public and private investments.

system. Estimates are of the order of 4% of GDP, for the 2010–2050 period, or about 4% of GDP, if demand-side investment are included. Meeting the sustainable development targets would first of all lead investments in a different direction. Moreover, additional investments would be needed, certainly in the short term. Most estimates of additional investments to reduce greenhouse gas emissions are of the order of 1% to 2% of GDP. Many reduction options tend to be capital-intensive and also more expensive than fossil-fuel-based alternatives. In the long term, however, technology development is likely to reduce the additional costs. It will be necessary to raise the required level of investment to finance the transition, both in developed and developing countries.

Preparing adaptation strategies for climate change would be sensible
The emission reductions assumed in the Challenge pathways would likely lead to an increase in global mean temperature of less than 2 °C. Uncertainties in the climate system, however, imply that warming may also be 3 °C or more, even if emission reductions are successful. There is also the risk of not achieving the emission targets. In other words, countries will need to adapt to climate change and prepare for the impacts of a 2 °C warming, and possibly more than that. It should be noted that part of the adaptation measures to climate change can be introduced at relatively short notice and therefore do not need long-term planning. However, other adaptation measures are slow, such as the raising of dykes and adapting urban planning.

4.3 Related challenges

The land–biodiversity and energy–climate challenges are directly related to other sustainable development issues, such as preventing water scarcity, reducing the imbalances in the Earth's nutrient cycles and preventing damage to human health. These challenges are briefly discussed below, in relation to the critical linkages. Mostly the implications of the food and energy policies are being addressed, but we have also briefly looked into the effectiveness of additional measures.

Water stress is likely to remain an important issue in 2050, even in the Challenge pathways
Many regions worldwide are seriously affected by an imbalance between availability and withdrawal of water (water stress). Agriculture is the main user of water, while water use is increasing most rapidly in the industrial and energy sectors. Water demands are projected to increase strongly, under the *Trend* scenario, and this is projected to result in a doubling of the number of people living under conditions of severe water stress. In the Challenge pathways, water demand is lower, as a result of changes in agricultural production and the impacts of climate policy on the energy system (mainly by reducing demand for thermal cooling). In addition, more efficient water-using equipment would also reduce water stress. The reduction in the number of people living under severe water stress, however, is only limited.

There are various policy instruments to reduce water scarcity, including integrated water resource management, comprising water pricing, regulated access to resources, investing in infrastructure. These and other policy instruments reflecting water scarcity are called upon to adapt to widespread and persistent water shortages. Water pollution prevention and waste-water treatment facilities, also in connection with enhanced sanitation schemes, will improve water quality, thereby enhancing the opportunities for the re-use of water.

Improving access to safe drinking water and basic sanitation requires significant investments in infrastructure expansion. The related additional demand for fresh water would be small compared to total demand and, therefore, would not significantly exacerbate the water scarcity situation. Furthermore, the befits of increased access are high, mainly due to reduced collection time and less health loss from waterborne diseases.

Increasing global food production, involving increases in crop yields, inevitably will push up phosphorus and nitrogen use, which may be mitigated by consumption changes and recycling

Globally, nitrogen and phosphorus fertiliser use inevitably will increase, in order to sustain increasing food production. This increase will be particularly strong in developing countries. Under each of the three pathways, the required additional large increases in crop yields would increase this fertiliser use even further. This effect could only be mitigated by consumption measures, including significant improvements in crop and livestock production, recycling of human excreta and a better integration of animal manure in crop production systems. Strategies for recycling phosphorus (human phosphorus, livestock phosphorus) seem to be most effective, particularly in industrialised countries. Applying these strategies could reduce annual phosphorus fertiliser use from primary sources by 26%, from 26 to 19 million tonnes of phosphorus by 2050. Nevertheless, although the pathways show that agricultural nutrient use may be reduced, compared to the *Trend* scenario, there would still be an increase from today's levels, primarily in transitional and developing countries.

Providing full access to food, water, sanitation and energy could avoid more than 800,000 child deaths, per year, by 2050

Increasing the access to sufficient food, safe drinking water, basic sanitation and modern sources of energy would yield important improvements in the global health situation, by reducing the impacts of infectious diseases, such as diarrhoea and respiratory infections. Providing full access to these basic goods and services would avoid more than 30% or roughly 800,000 child deaths, annually, by 2050, compared to the situation under the *Trend* scenario. Although this would be a significant improvement, globally, the MDG target on child mortality will not be achieved before 2030, mainly due to persistent high child mortality rates in sub-Saharan Africa and South Asia. To achieve the MDG target, policies that address access to food, water and energy also would need to include certain quality aspects of this access, such as those

related to nutrition and water. Furthermore, the broader socio-economic setting would need to be improved, as well, including health services and health education, with a specific focus on female education.

It is important to note that, although reducing the impact of infectious diseases would lead to many health life years gained, the disease burden of chronic diseases would increase, especially at advanced ages. By 2030, the two most dominant chronic diseases (cardiovascular disease and cancers) are projected to make up around 50% of all global deaths. Several environmental factors connected to food consumption, energy emissions, climate change, and a poor quality of the physical environment, are risk factors with respect to these diseases (e.g. through physical inactivity, unfavourable diets, obesity, urban air pollution, heat and cold stress-related mortality). Reducing these risks, as is part of the goals for 2050 as described in this report, thus would have a significantly favourable impact on population health.

4.4 Synergies and trade-offs

The analysis has indicated different pathways for reaching sustainable development goals, but combining certain elements of these pathways may be more effective
The analysis has shown that each pathway is ambitious and faces specific trade-offs. Given the urgency of the problems analysed, a more robust strategy would be to combine certain elements from different pathways; for instance, consumption changes and technological changes focused on large-scale supply-side change and more decentralised solutions. The additional advantage of such an approach would be that different options appeal to different actors; a broad strategy would do more justice to pluriformity in society, and would mobilise its energy. Obviously, combinations would have to be coherent, and the scope for choosing combinations varies depending on the subject. Some choices must be made at the national or supranational level (e.g. emission trading schemes), others could be made at subnational level (e.g. indication of regions dedicated to intensive agriculture, versus regions where agriculture and nature are intertwined), or even at an individual level.

Important synergies and trade-offs exists, which implies that integrated responses would be required
Reducing air pollution, for instance, would lead to important synergies for climate change mitigation (depending on the type of air pollution), improve access to food and protect biodiversity. These benefits would be immediate, which could raise the appraisal of these measures. Important linkages (both synergies and trade-offs) also exist between increased food production and climate change. Table 3 identifies some of the main linkages between the different sustainable development goals considered in this report. It shows that many synergies exist, but there are also some important trade-offs. Policies would have to take account of both, for example:

- Sustainable access to enough food, safe drinking water, improved sanitation and modern energy sources would improve health, significantly – especially for small

children. It would also create wealth, both directly and indirectly; for example, by freeing up time to be used for activities other than the collection of water and firewood.
- Sound ecosystem management and restoration of degraded ecosystems may result in cleaner and more reliable water sources, higher carbon uptakes by natural areas, and improved soils that would sustain a higher agricultural production.
- In the energy field, an integrated approach to achieving climate, air pollution and energy security targets could lead to significant cost reductions.
- Changing dietary patterns may also have important co-benefits. It would not only help to reduce biodiversity loss, but it would also contribute to achieving the climate goal.
- A major trade-off involves bio-energy. This could help to achieve the climate goal, but would complicate achieving those for biodiversity and food. Here, sustainability criteria and monitoring would be needed to keep the negative impacts within acceptable bounds.
- Certain air pollution measures, such as reducing black carbon emissions and ozone precursor emissions, may lead to improved health, reduce climate change and prevent ecosystem damage.

5 Transforming global governance for sustainable development

The previous sections identified important gaps between our *Trend* scenario and the sustainable development goals. However, they also showed that there is a clear potential for achieving these goals, and indicated key policy actions for the coming 10 years. Obviously, the barriers identified in Sections 3 and 4 would form major obstacles to progress.

This report suggests a governance approach that is based on a shared vision with long-term goals and consistent short-term targets, combining strengthened government actions with the numerous civil and corporate initiatives, worldwide
Adaptations to the current approach would consist of an increased focus on creating a reliable long-term vision, combined with stimulating learning and innovation. Incentive structures should match these long-term goals. However, it may be sensible to start, pragmatically, by taking many small steps in the right direction, building more strongly on the innovative capacity of citizens and businesses, worldwide. By exploring best practices, diffusing technologies and making incremental improvements, support and understanding may be created for the more radical changes that are required. Such an approach could be based on the following key elements (as elaborated in Sections 5.1 to 5.4):

1. develop a consistent vision with long-term goals and short-term targets, integrating various areas of sustainable development;

2. ensure that the rules and regulations which govern day-to-day decision-making are adapted to create the right incentive structure for transformative changes;
3. increase coherence between relevant decision-making processes;
4. reform policy-making at an international level, based on three complementary strategies.

A key aspect of this approach is the focus on learning and innovation
Transformative changes are required to reach the sustainability goals, both in terms of human activities and their underlying systems. In many cases, it is difficult to see exactly how such changes could be implemented – and therefore exploring different routes and experimentation with policy instruments is required. This learning process is sometimes characterised as 'radical incrementalism'. Changes would need to be radical, in order to shift them in the direction of true alternatives, rather than seeking small efficiency gains along current routes. However, there are no blueprints for achieving targets, and big changes are difficult to implement. Therefore, decision-making would need to be a 'step-wise' process of acting and learning.

5.1 Develop a consistent vision with long-term goals and short-term targets, integrating various areas of sustainable development

A global consensus on a long-term vision and goals and related short-term targets could act as a guiding star for sustainable development policies
Currently, an overall vision on sustainable development is lacking. Although visions are sometimes regarded as soft tools, they may have a serious effect if they mark the clear choice for a sustainable future. An agreement on a sustainable development goal-setting framework could be an important step towards a more integrated approach to tackling global problems, by providing direction for a green and inclusive economy. Experience with international environmental agreements and the MDGs has shown that such goals could help decision-making as a 'guiding star'. Long-term vision and short-term targets would need to address important sustainable development themes, such as food, energy and water and include the economic, social and environmental domains of sustainable development.

Sustainable development goals must be relevant for all countries
Generally, the MDGs have put forward a set of positive targets that need to be achieved if poor people are to escape poverty. The sustainable development agenda, however, is quite different. For many sustainable development issues different opinions exists, causing goals to be more contested, thus complicating the negotiations. Integrated development and environmental goal-setting would need to focus on poverty reduction for the poorest in the world, but also guide sustainable development pathways and sustainable production and consumption for middle-income and industrialised countries. There is a risk of diverging the MDG into the more politically difficult territory of sustainable development, which could weaken international effort on extreme poverty. However, if successful, they would contribute to the kind of results-based

system and accountability that is currently often lacking in important areas of sustainable development.

This implies that the process of developing a set of meaningful sustainable development goals would need to be carefully designed. These goals, in addition to being meaningful in terms of reaching long-term sustainable development goals, also would need to enable politically feasible targets to be set for the shorter term. Clearly, a fair number of issues may arise during elaborations on such goals. These elaborations would require political decisions to be made on issues related to the areas to be covered and to whom they would apply. In addition, decisions would need to be made about the character of the agreement itself. Addressing these issues would be a highly political process. Therefore, it would be important to organise a balanced, inclusive and fair process that would lead to genuine consensus. One way of achieving this would be to initiate a strong process, running between the Rio+20 conference and the expiry of the MDGs in 2015, involving experts and stakeholders, to come up with a post-2015 set of sustainable development goals that combine development and environmental goals.

5.2 Ensure that the rules and regulations which govern day-to-day decision-making are adapted to create the right incentive structure for transformative changes

Transitions may build on the many existing initiatives within society
Society has an enormous capacity for innovation and learning (in this report, referred to as the energetic society). It is important to ensure that this capacity is channelled towards sustainable development, by ensuring that sustainable development considerations become part of the decision-making process. It is important to recognise that a large number of initiatives are already being undertaken to realise more sustainable development, worldwide. Exactly these initiatives could prove to be the seeds of possible transitions. Public policies need to better capitalise on the numerous civil society, consumer and business initiatives regarding sustainable development, which have been created thanks to or in spite of government policies. A key step for society would be to create convergence on a shared vision and policy objectives (formulated in a positive way, 'the future we want', instead of a negative formulation, 'action that is needed'). Sustainable development goal-setting, as discussed in the previous section, will be important in this regard. By approaching sustainability issues from a societal perspective, governments may gain effectiveness and legitimacy if they view society as producers and allow scope for further cooperation between public organisations, businesses and citizens.

In using the innovation capacity of society, it would important to weigh sustainable development objectives in day-to-day decision-making
Sustainable development considerations would need to be accounted for in public and private decision-making, and to channel the energy in businesses and civil society into the right direction. New rules could be introduced; for instance, in accounting systems

or risk insurance. This could also be done by providing a physical and institutional infrastructure that fosters more sustainable consumption patterns, influencing citizens' choices by changing the default (e.g. by providing smart grids, or by making vegetarian diets the standard) and by strengthening monitoring and feedback mechanisms (e.g. information on energy use and smart metering). Other examples may include voluntary certification schemes, extended producer responsibility and green procurement by governments.

In order to support the vision, there is a need for criteria by which to evaluate the various suggested solutions to achieve corresponding goals. An agreement on the adjustment of key progress indicators (such as the 'Beyond GDP agenda') would be key.

The general approach is to stimulate innovation through a combination of push and pull policies. Possible policy instruments include:

- abolish perverse incentives (e.g. environmentally harmful subsidies);
- define natural resource access and tenure rights and ensure that green policies and investments also focus on poverty reduction;
- strengthen the capacity for institutional learning;
- introduce dynamic regulation stimulating continuous improvement, reinforced by extensive public procurement commitments;
- include sustainable development goals in the indicators used to measure progress;
- include environmental factors in current pricing systems (e.g. green taxation and payments for ecosystem services);
- develop enabling infrastructure, such as smart grids and sustainable city design;
- strengthen monitoring and feedback mechanisms, such as smart metering.

5.3 Increase coherence between relevant decision-making processes

Policy coherence is important: integrated responses may reap important benefits

The challenges posed by sustainable development are not only influenced by specific environmental and development policies, but also by other policy areas, such as trade, finance and energy. Therefore, it is crucial to increase the coherency between policy domains, long- and short-term goals and levels of decision-making, all focused on sustainability as the overarching target. There are important synergies and trade-offs along the pathways towards achieving the sustainability goals. Several factors contribute to achieving multiple goals, such as efficiency improvements, consumption changes and reduced fossil-fuel use. Other factors may achieve one goal but have negative consequences for others, such as bio-energy and desalinisation. These connections are due to physical linkages between the different relevant variables, but they are not usually dealt with in an integrated manner in the related policy domains. Focusing on synergies may make it easier for agreements to be reached.

Linkages between sustainable development goals and the green economy – focus on innovation

This report demonstrates pathways towards achieving sustainability goals and greening the economy and contributing to poverty reduction. Economic growth that does not take into account the natural resource base cannot be sustained in the future. 'In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive'. Agreeing on new sustainable development goals is of little value if there is no subsequent change to the rules of the game for a green and inclusive economy.

5.4 Reform policy-making at an international level, based on three complementary strategies

International collaboration will remain a key element of policies that aim to meet sustainable development goals. There are important advantages to this strategy, in terms of efficiency, cost-effectiveness and trust-building. So far, however, the diversity of interests between countries has meant that the multilateral level has been far less successful than hoped. However, action at international level, ineffective as it may be, could serve important legitimation and institutionalisation purposes for more effective action on other levels or within the private sector.

Three complementary strategies for international collaboration are suggested that together may be better able to kick-start and push the transition:

- realise international sustainability goals and the greening of the economy by forming new coalitions of the willing;
- reframe sustainability action to find new concepts and narratives that could mobilise citizens, businesses and governments;
- reform the current multilateral system for sustainability.

None of these strategies are new, but they are not usually considered in combination. In practice, a balance would need to be found between bottom-up initiatives within societies, on the one hand, and top-down steering by providing vision, regulation and enabling frameworks, on the other.

Strategy 1: Build on societal initiatives to form new coalitions of the willing

In this strategy, public policies would be aimed to better capitalise on the numerous civil society, consumer and business initiatives for sustainable development that are being undertaken, worldwide, thanks to or in spite of government policies. For some issues, focus on a small number of multinational companies that dominate the market could make a large difference, also sectoral or regional approaches may work better. Traditional state powers can play a key role in 'unleashing' these societal energies. To be part of a global transition towards sustainability, safeguards that ensure the legitimacy and accountability of non-state actors would also need to be put in place.

Strategy 2: Reframe sustainable development to find new mobilising concepts and narratives

There are ways to reformulate sustainable development issues in order to make them easier to implement. Some of these frames, for instance, prioritise more direct gains – combining these with improving the system in the long term (e.g. energy security or air pollution). It will be important to emphasise those sustainable development strategies that provide clear benefits to the countries involved; in other words, these strategies would need to relate to the aspirations and primary concerns of countries, civil society and businesses. Applying market mechanisms to the logic of the transition towards a green and inclusive economy at least would help this transition to be considered as something that may be co-produced by the players in the current system. The idea of a 'shared development agenda' for a safe and fair operating space does provide a frame that may bring development and the environment together. It is, for example, also conceivable that a greening of the economy will be furthered through an 'Earth Race', as Thomas Friedman called it – a competition between national societies and companies which, from their perceptions of their own strategic interests, choose to green their futures. In this frame, the role of government will be to create a level playing field. There may also be major concerns amongst developing countries that they might lose out, something which also needs to be taken into account. Nevertheless, this is a powerful discourse that helps to understand what is happening in many developing and developed countries, worldwide.

Strategy 3: Reform the current multilateral system for sustainability

Last but not least, through a number of reforms, the multilateral system for sustainability also needs to be strengthened to further many of the necessary policies and actions identified, so far. Shortcomings in the institutional architecture of sustainable development need to be remedied. First of all, the lack of integration of economic, social and environmental policies in the UN system towards stronger policy coherence for sustainability needs to be addressed. One option currently being discussed is the creation of a high-level UN Sustainable Development Council that would replace the UN Commission on Sustainable Development. Secondly, institutional fragmentation could be addressed by upgrading the UN Environment Programme to a full-fledged international organisation that is more on a par with other international organisations. Thirdly, a stronger role could be given to non-governmental organisations, which is also relevant as a link to the strategies presented in this report. Fourthly, in order to integrate knowledge, it seems important to consider creating a global assessment facility that could provide policymakers with accurate and uncontroversial information and analysis. Instead of a new institute, it could be a network of existing organisations currently working in this area. Fifthly, in the implementation of policies for specific issues, such as land use, water and energy, more attention should be given to policy coherence.

6 To conclude: will a pragmatic approach be enough to meet sustainable development goals?

As we have shown, historical experience does not bode well for meeting sustainable development goals. It has often been argued that, given the magnitude of change, this would best be addressed through a large-scale, systemic, preferably internationally coordinated effort. However, recent experiences with multilateral action also have shown the limitations of such an approach. In looking for politically feasible actions, therefore, we looked for approaches that would be multi-scale in nature and stimulate innovation, recognising interdependencies between levels and policy domains. Within this approach, we suggest to look for small steps to be taken into the right direction and to ensure that no decisions are taken that would lead into the wrong direction. It is important especially to build on the many initiatives emerging within society, because at this level most innovation processes take place. Policies could help to ensure that, instead of going in different directions, these processes actually move society as a whole towards achieving the sustainable development goals.

The question remains whether these initiatives will be enough to realise transformative changes and to implement large-scale technologies, as this would probably require a strong enabling and regulatory role of governments. This report provides a discussion on some of the key elements of such a pragmatic approach. There is a certain amount of tension between the transformative changes required to realise sustainable development and the pragmatic policy approach, if changes cannot be made in time. However it seems that, currently, there are few other options. Not meeting sustainability challenges will involve serious costs, and the most vulnerable within society, worldwide, will be the first to pay that price.

Table 3

Interactions between interventions to accomplish goals

Effects on / Action to	Eradication of hunger	Universal access to safe drinking water	Universal access to modern energy	Ensuring clean air	Climate change mitigation	Halting biodiversity loss
Eradicate hunger		ns	ns	ns	More GHG emissions from increased production (fertilisers; land expansion, tractors)1)	More impact of agriculture on ecosystems
Universal access to safe drinking water	Access to safe drinking water helps to prepare safe food Competition as well as synergy between water for residential use and in agriculture		ns	ns	ns	ns
Universal access to modern energy	Allows making use of income opportunities when less time is spent on collecting fuels, and health improved through less indoor air pollution	Water required for power generation Modern energy helps to improve access to safe water (e.g. pumps)		Less pollution from traditional energy sources (charcoal, firewood)	Less deforestation vs more fossil-fuel use, but modern energy more efficient than traditional energy systems	Less disturbance of natural ecosystems from wood collection for fuel or charcoal
Ensuring clean air	Less impact of air pollution on crop yields and quality	Less contamination from the deposition of airborne pollutants	ns		Depends on the choice of air pollutants to be targeted (BC/CH_4)	Lower deposition of atmospheric pollutants on ecosystems

Effects on / Action to	Eradication of hunger	Universal access to safe drinking water	Universal access to modern energy	Ensuring clean air	Climate change mitigation	Halting biodiversity loss
Mitigate climate change	Less risk of disruption of vital ecosystem services	Effects of climate change on precipitation patterns and potential evapo-transpiration	Higher energy price	Less pollution thanks to a reduced use of fossil fuels, particularly oil and coal		Less impact of climate change on biodiversity
	Bio-energy competes with food and feed and may spur scrambles for land; but also opportunities for poor in rural areas					Effects of GHGs and climate change on crop yields
						Additional land required for bio-energy crops
Halt biodiversity loss	Less land used for food production	A more gradual / uniform flow and cleaner water to rivers and aquifers	ns	More intact ecosystems contribute to air quality	Fewer CO2 emissions from land conversion and agriculture Restoration of degraded land creates new CO2 sinks	
	Preservation of ecosystem services helps safeguard long-term sustainable food supply	Increased water use by permanent vegetation				

Type of interaction: positive; negative; mix of positive and negative; ns: no significant interactions expected (until 2050).

In 1992, in Rio de Janeiro, governments worldwide agreed to work towards a more sustainable development that would eradicate poverty, halt climate change and conserve ecosystems. Although progress has been made in some areas, actions have not been able to bend the trend in other, critical areas of sustainable development, such as providing access to sufficient food and modern forms of energy, preventing dangerous climate change, conserving biodiversity and controlling air pollution. Without additional effort, these sustainability objectives also will not be achieved by 2050.

This report analyses how combinations of technological measures and changes in consumption patterns could contribute to achieving a set of sustainability objectives, taking into account the interlinkages between them. The focus is on identifying the necessary level of effort, possible pathways, synergies and trade-offs. In a technical sense, the potential exists for achieving all of the objectives. However, the question to be answered is: What sort of governance structures could bring about the transformative changes required to meet the sustainable development objectives? We suggest that a pragmatic governance approach that consists of a shared vision for 2050, strengthened short-term targets, and strong policy actions by governments, building on the strength of civil society and business, could bring us further along the roads that lead from the 2012 Rio Conference into the future.

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