UNIVERSITY OF LONDON

SOAS University of London

Centre for Development, Environment and Policy

P234

Low Carbon Development

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About this Module

This module explores the main issues around climate change mitigation and low carbon development. Global climate change poses a serious threat to international development efforts. Developing countries – especially the poorest – have historically contributed very little to climate change. However, they are often the most vulnerable to climate change due to their limited resources and limited capacity to adapt to climate change. At the same time, developed countries and emerging economies are struggling to mitigate emissions that lead to climate change. To mitigate the emissions leading to climate change and achieve human development, there is a need for serious global commitment to low carbon development. Low carbon development is a new development model, which aims to achieve these two goals simultaneously.

This module elaborates the key issues and concepts in the field of climate change mitigation and low carbon development; it discusses how greenhouse gas emissions can be mitigated in various sectors and in different types of countries and explores how low carbon development can be implemented in policy and practice. The module also critically discusses some of the global and national challenges, as well as addressing policy responses, such as those of the United Nations Framework Convention on Climate Change (UNFCCC).

Structure of the Module

The module is divided into three parts:

Part 1 introduces the origins, concepts and key issues related to low carbon development and climate change development. It discusses the links and inter-dependencies between climate change, greenhouse gas emissions and development (Unit 1). Unit 2 explores long-term scenarios for climate change mitigation and a low carbon transition. Units 3–7 explore the political, social, economic and technological dimensions of low carbon development and climate change mitigation.

Part 2 explores sectoral approaches to low carbon development and climate change mitigation, with particular reference to energy (Unit 8), industry, transportation and cities (Unit 9), forestry (Unit 10) and agriculture (Unit 11). For agriculture, the role of non-carbon dioxide greenhouse gas emissions, such as methane and nitrous oxides, will be elaborated and wider strategies for low emissions development will be discussed.

Part 3 presents the opportunities and barriers for low carbon development and climate change mitigation in policy and practice, with a focus on low- and middle-income countries (Units 12 and 13) and high-income countries (Unit 14). The role of emerging economies, that are also emerging greenhouse gas emitters, such as China, India and South Africa, is also explored. Unit 15 discusses how low carbon development and climate change mitigation can be more aligned with climate change adaptation and poverty reduction.

WHAT YOU WILL LEARN

Module Learning Outcomes

By the end of this module, students should be able to:

- understand the links and recognise inter-dependencies between climate change, greenhouse gas emissions and development.
- critically discuss the opportunities and barriers to climate change mitigation and low carbon development.
- critically discuss the key issues and concepts in the field of climate change mitigation and low carbon development from a theoretical and practical perspective.
- understand low carbon pathways and their implications.
- be familiar with and interpret national and international policy responses to climate change mitigation and low carbon development.

ASSESSMENT

This module is assessed by:

- a 1000-word commentary and critical discussion on a key reading, and assessment of the commentaries of two other students (10%)
- a 3000-word examined assignment (EA), worth 40%
- a two-hour written examination worth 50%.

Since the EA is an element of the formal examination process, please note the following:

(a) The EA questions and submission date will be available on the Virtual Learning Environment (VLE).

(b) The EA is submitted by uploading it to the VLE.

(c) The EA is marked by the module tutor and students will receive a percentage mark and feedback.

(d) Answers submitted must be entirely the student's own work and not a product of collaboration.

(e) Plagiarism is a breach of regulations. To ensure compliance with the specific University of London regulations, all students are advised to read the guidelines on referencing the work of other people. For more detailed information, see the FAQ on the VLE.

STUDY MATERIALS

There is one textbook for this module.

- Urban, F. & Nordensvärd, J. (2013) *Low Carbon Development: Key Issues*. Oxon, UK, Earthscan.

The textbook *Low Carbon Development: Key Issues* contains comprehensive insights on the conceptual, empirical and policy-related issues of low carbon development. The book is interdisciplinary in its nature drawing on insights from socio-economics, politics and environmental sciences. The book first explores the need for low carbon development in a carbon constrained world and the concept of low carbon development. It then discusses the key issues of socio-economic, political and technological nature for low carbon development, addressing issues such as the political economy, social justice, climate finance and innovation for low carbon technology. This is followed by key issues for low carbon development in policy and practice, which is presented based on cross-cutting issues such as energy policy, forestry, agriculture, transport and low carbon city planning. The book contains practical case studies from low carbon development in low-income countries in Africa, middle-income countries in Asia and Latin America and high-income countries in Europe and North America. The contributors to this book are leading academics and practitioners in the field of low carbon development. This book is an essential reading for students, academics, professionals and policymakers interested in the field of low carbon development, climate change mitigation, climate policy and energy policy.

For each of the module units, the following are provided:

Key Study Materials

Key readings are drawn mainly from the textbooks, relevant academic journals and internationally respected reports. They are provided to add breadth and depth to the unit materials and are required reading as they contain material on which you may be examined. Readings are supplied as digital copies and ebooks via the SOAS Online Library. For information on how to access the Library, please see the VLE.

For some units, multimedia links have also been provided. You will be invited to access these as part of an exercise or activity within the unit, and to discuss their implications with other students and the tutor.

Further Study Materials

These texts and multimedia are not always provided, but weblinks have been included where possible. Further Study Materials are **NOT** examinable; they are included to enable you to pursue your own areas of interest.

References

Each unit contains a full list of all material cited in the text. All references cited in the unit text are listed at the end of the relevant units. However, this is primarily a matter of good academic practice: to show where points made in the text can be substantiated. Students are not expected to consult these references as part of their study of this module.

Self-Assessment Questions

Often, you will find a set of **Self-Assessment Questions** at the end of each section within a unit. It is important that you work through all of these. Their purpose is threefold:

- to check your understanding of basic concepts and ideas
- to verify your ability to execute technical procedures in practice
- to develop your skills in interpreting the results of empirical analysis.

Also, you will find additional **Unit Self-Assessment Questions** at the end of each unit, which aim to help you assess your broader understanding of the unit material. Answers to the Self-Assessment Questions are provided in the Answer Booklet.

In-text Questions

? This icon invites you to answer a question for which an answer is provided. Try not to look at the answer immediately; first write down what you think is a reasonable answer to the question before reading on. This is equivalent to lecturers asking a question of their class and using the answers as a springboard for further explanation.

In-text Activities

✍ This symbol invites you to halt and consider an issue or engage in a practical activity.

Key Terms and Concepts

At the end of each unit you are provided with a list of Key Terms and Concepts which have been introduced in the unit. The first time these appear in the study guide they are ***Bold Italicised***. Some key terms are very likely to be used in examination questions, and an explanation of the meaning of relevant key terms will nearly always gain you credit in your answers.

Acronyms and Abbreviations

As you progress through the module you may need to check unfamiliar acronyms that are used. A full list of these is provided for you in your study guide.

TUTORIAL SUPPORT

There are two opportunities for receiving support from tutors during your study. These opportunities involve:

(a) participating in the Virtual Learning Environment (VLE)

(b) completing the examined assignment (EA).

Virtual Learning Environment (VLE)

The Virtual Learning Environment provides an opportunity for you to interact with other students and tutors. A discussion forum is provided through which you can post questions regarding any study topic that you have difficulty with, or for which you require further clarification. You can also discuss more general issues on the News Forum within the CeDEP Programme Area.

INDICATIVE STUDY CALENDAR

Part/unit	Unit title	Study time (300 hours)	Study week (16 weeks)
PART I	**Different Perspectives on Low Carbon Development**		
Unit 1	Low Carbon Development and Climate Change Mitigation: Origins, Concepts, Opportunities and Challenges	15	1
Unit 2	Long-term Scenarios for Climate Change Mitigation and Low Carbon Development	15	2
Unit 3	The Policy Processes and Politics of Low Carbon Development	15	3
Assessment	*Critical Commentary and Peer Assessment*	10	3—4
Unit 4	The Social Dimensions of Low Carbon Development	15	4
Unit 5	The Economics of Low Carbon Development	15	5
Unit 6	Technology and Innovation for Low Carbon Development	15	6
Unit 7	The Health Implications of Low Carbon Development	15	7
PART II	**Sectoral Approaches to Low Carbon Development**		
Unit 8	Energy	15	8
Assessment	*Examined Assignment*	25	9
Unit 9	Industry, Transportation and Cities	15	10
Unit 10	Forestry	15	11
Unit 11	Agriculture	15	12
PART III	**Low Carbon Development in Policy and Practice**		
Unit 12	Low Carbon Development in Low-income Countries	15	13
Unit 13	Low Carbon Development in Middle-income Countries	15	14
Unit 14	Low Carbon Development in High-income Countries	15	15
Unit 15	Low Carbon Climate Resilient Development/ Climate-compatible Development	15	16
Assessment	*Revision and Examination*	40	After end of study session

Unit One: Low Carbon Development and Climate Change Mitigation: Origins, Concepts, Opportunities and Challenges

UNIT INFORMATION

Unit Overview

This unit introduces the topic of low carbon development and climate change mitigation. It introduces the origins, concepts, opportunities and barriers related to low carbon development and climate change mitigation. It discusses the links and interdependencies between climate change, greenhouse gas (GHG) emissions and development. This unit explains the need for low carbon development and it also highlights challenges to its implementation.

Unit Learning Outcomes

By the end of this unit, students should be able to:

- define low carbon development and climate change mitigation
- understand the links and recognise interdependencies between climate change, GHG emissions and development
- critically discuss the origins, aims and limitations of low carbon development and climate change mitigation
- critically discuss the challenges of and barriers to low carbon development and climate change mitigation.

KEY STUDY MATERIALS

Sections 1 and 2

- Urban, F. & Nordensvärd, J. (2013) Low carbon development: Origins, concepts and key issues. In: *Low Carbon Development: Key Issues*. Oxon, Earthscan, Routledge. pp. 3–19.

Read Chapter 1. This module is based on the above textbook. The book includes all the relevant knowledge you will need for this module, except when additional key study materials are required. You may wish to read the entire book if you have time or, alternatively, read the recommended chapters. In this textbook, Urban and Nordensvärd have produced the first comprehensive introduction to low carbon development. The rationale for the book and this module is as follows:

Global climate change poses a serious threat to international development efforts. Developing countries – and especially the poor – have historically contributed very little to climate change. However, they are often the most vulnerable to climate change due to their exposure to climatic impacts, their limited resources and limited capacity to adapt to climate change. At the same time, developed countries are struggling to mitigate emissions that lead to climate change. To **mitigate the emissions leading to climate change and achieve human development**, there is a need for serious global commitment to low carbon development. Low carbon development is a new development model, which aims to achieve these two goals simultaneously. *Low Carbon Development: Key Issues* fills a crucial gap by being oriented towards postgraduates, undergraduates, experts, practitioners, company representatives and policymakers interested in the fields of climate change and development, as well as low carbon development and the low carbon economy. In addition, the interdisciplinary book bridges the divide between more technical and natural science-based books about climate change, mitigation, energy and more social science-based books about sustainable development and international development. The book serves both as a comprehensive introduction to low carbon development and as a key study material on low carbon development concepts, policies and practices in developed and developing countries. The book presents practical solutions for how low carbon development can be achieved at the global level.

The general argument of the book is that low carbon development is essential for mitigating the emissions that lead to climate change and for enabling development in a carbon-constrained world. Low carbon development can bring opportunities and benefits for both developed and developing countries, nevertheless low carbon development can only be implemented when an adequate enabling environment is in place that addresses the political, economic, social and technological key issues. In low-income and lower-middle-income countries, issues of social justice and poverty reduction are the key to low carbon development, while for higher-middle-income and high-income countries, low carbon innovation and emission reductions are at the heart of implementing low carbon development.

Chapter 1 provides an introduction to the book. It introduces low carbon development by discussing the origins, concepts and key issues relevant for low carbon policy and practice. The chapter further elaborates some of the critiques that relate to low carbon development.

❖ Mulugetta, Y. & Urban, F. (2010) Deliberating on low carbon development. *Energy Policy*, 38 (12), 7546–7549.

This short paper addresses the need for low carbon development and specifically mentions the role of individual communities in achieving a low carbon transition. Low carbon development is a much-used term in development circles today. As such, governments are actively exploring how to achieve their growth targets through a low carbon trajectory or even through a carbon neutral pathway. This is a new area that challenges how development has been done so far, calling for not only a serious rethink of old practices but also contesting entrenched value systems. From this viewpoint, it explores some of the underlying issues that are driving the process of mainstreaming climate change in development. Recognising that there are variations in low carbon development, it maps out the diversity of understanding and interpretations with a view to laying out the range of possibilities that countries can consider. It argues that while countries should certainly draw lessons from the experiences of others on mainstreaming climate change in their policies and practices, the version of low carbon development that each country follows needs to emerge from within its own national reality, anchored in its development prospects, aspirations and capacities.

❖ Skea, J. & Nishioka, S. (2008) Policies and practices for a low-carbon society. *Climate Policy, Supplement Modelling Long-Term Scenarios for Low-Carbon Societies*, 8, 5–16.

This paper defines what is meant with low carbon society and addresses opportunities for it by using a modelling approach. The study guide works with the definition of low carbon society that is given by Skea and Nishioka, see p. S6.

❖ Urry, J. (2013) A low carbon economy and society. *Philosophical Transactions of the Royal Society A*, 371, 1–12.

This paper examines various aspects of moving from high carbon economies and societies to low carbon systems, using a sociological framing. First, some historical material is considered from the Second World War and the 1970s, periods with some lessons for the contemporary 'powering down' of whole societies. Second, analysis is provided of some green shoots of a powering down of existing systems identifiable in the contemporary developed world. Third, analysis is provided of the array of systems, social practices and innovations that would have to develop in order to effect powering down on a sufficient scale and within an appropriate time period. Most examples are drawn from transport and mobility. Finally, the paper demonstrates just why developing new systems is so hard, especially as this must involve a transformed cluster of systems. The paper argues that the forces that make a new cluster unlikely are exceptionally powerful and make this a very difficult but not impossible outcome.

❖ Grubb, M. (2001) Who's afraid of atmospheric stabilisation? Making the link between energy resources and climate change. *Energy Policy*, 29 (11), 837–845.

This paper argues that we need to decarbonise energy systems and move towards low carbon economies and explains why and how. The distribution of fossil fuel reserves and resources between different regions and deposits has strong implications for climate change economics and policy. The task of stabilising the atmosphere is intimately linked to the question of long-term energy supplies as conventional petroleum reserves are depleted, notwithstanding debates about the scope for reserve extension through continued exploration and development. It suggests a supply-side component to complement the consumption orientation of existing climate policies: the task is to ensure that investment and innovation moves towards the 'low carbon frontier' instead of the 'high carbon frontier'. The paper argues that this also implies that the Organization of the Petroleum Exporting Countries (OPEC) countries have little to fear about the long–run impact of climate change policy. The priority is to deter development of more carbon-intensive unconventional petroleum deposits and technologies, and to ensure that the existing trends to diversify power generation sources continue and extend more widely over time. The paper argues that supply-side constraints will not solve the climate problem in themselves – but they make the task a lot easier, if the opportunities are taken.

❖ Sorrell, S., Speirs, J., Bentley, R., Brandt, A., & Miller, R. (2010) Global oil depletion: A review of the evidence. *Energy Policy*, 38 (9), 5290–5295.

Within the polarised and contentious debate over future oil supply a growing number of commentators are forecasting a near-term peak and subsequent decline in production. But although liquid fuels form the foundation of modern industrial economies, the growing debate on 'peak oil' has relatively little influence on energy and climate policy. With this in mind, the UK Energy Research Centre (UKERC) has conducted an independent, thorough and systematic review of the evidence, with the aim of establishing the current state of knowledge, identifying key uncertainties and improving consensus. The study focuses upon the physical depletion of conventional oil in the period to 2030 and includes an in-depth literature review, analysis of industry databases and a detailed comparison of global supply forecasts. This paper summarises the main findings of the UKERC study. A key conclusion is that a peak of conventional oil production before 2030 appears likely and there is a significant risk of a peak before 2020.

Section 3

❖ Jakob, M. & Steckel, J.C. (2013) How climate change mitigation could harm development in poor countries. *WIREs Climate Change*, 5 (2), 161–168.

This paper suggests that avoiding dangerous climate changes requires emission reductions in not only industrialised but also developing countries. This opinion piece argues that even if the 'full incremental costs' of abatement in developing countries would be covered by industrialised countries, the former's development prospects could be hampered by climate change mitigation for the following reasons. First, financial inflows have the potential to induce a 'climate finance curse' similar to adverse effects related to natural resource exports. Second, increased use of more expensive low carbon energy sources could delay structural change and the build-up of physical infrastructure. Third, higher energy prices could have negative effects on poverty and inequality. The authors conclude that these considerations should not be seen as an indication that one should abstain from emission reductions in developing countries. However, the paper argues that until developing countries' most severe concerns can be appropriately addressed, attention should be focused on measures that promote human well-being while saving emissions.

❖ Anderson, K. (2013) Avoiding dangerous climate change demands de-growth strategies from wealthier nations. *Articles and Commentary: kevinanderson.info.* [Weblog]. 25 November 2013.

Available from: http://kevinanderson.info/blog/avoiding-dangerous-climate-change-demands-de-growth-strategies-from-wealthier-nations/

1.0 DEFINING LOW CARBON DEVELOPMENT

Section Overview

This section introduces the topic of low carbon development and climate change mitigation. It provides key definitions and discusses why low carbon development is important to achieving human development in a changing climate.

Section Learning Outcomes

By the end of this section, students should be able to:

- define low carbon development and climate change mitigation
- recognise the need for low carbon development and its link to climate change.

1.1 Low carbon development: what is it?

✍ Read pages 3 to 7 as well as the introduction of the textbook *Low Carbon Development: Key Issues* to understand what low carbon development is, how it is being defined and how it is linked to global climate change.

From here on, we define low carbon development as a 'development model that is based on climate-friendly low carbon energy and follows principles of sustainable development, makes a contribution to avoiding dangerous climate change and adopts patterns of low carbon consumption and production' (Urban & Nordensvärd, 2013: p. 5).

When we speak about low carbon development in this module, we imply low emissions development, thereby taking into account the fact that not only carbon dioxide (CO_2) emissions have to be reduced, but also other anthropogenic GHGs such as methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) (UNFCCC, 1997). CO_2 is the GHG that has the highest concentration in the atmosphere compared to other GHG, yet it is only one part of the solution (IPCC, 2013). It plays a major role in the energy sector, which in some countries accounts for about 50% of national GHG emissions (IEA, n.d. accessed 2015), as well as the transport, industry, services, housing, forestry and agriculture sectors. CH_4 and N_2O are the most common GHGs in the agricultural sector and HFCs, PFCs and SF_6 are common in the industrial sector. While this module acknowledges the fact that we are, in effect, dealing with low emissions development, and not only low carbon development, the low carbon development nomenclature is nevertheless used as it is widely employed around the world in literature, policy and practice and widely debated by policymakers, non-governmental organisations (NGOs), multilateral organisations, experts and academia, firms, the media and the public.

Read page 6 in the textbook to understand how low carbon development is related to other related concepts such as sustainable development, green growth and climate compatible development (also known as low carbon climate-resilient development).

? Urban and Nordensvärd (2013) distinguish between low carbon development and low carbon growth. What is the difference between the two?

Answer

'"In growth terms, low carbon development is defined as using less carbon for growth, which includes switching from fossil fuels to low carbon energy, promoting low carbon technology innovation and business models, protecting and promoting natural carbon sinks such as forests and wetlands, and formulating policies that promote low carbon practices and behaviours" (DfID, 2009: 58)"' Urban and Nordensvärd, 2013: p. 6.

In development terms, the scope of low carbon transitions is much broader than purely focusing on economic growth. Low carbon development requires broader societal, environmental, economic, technological and institutional changes and focuses on human development and the equitable distribution of resources.

✍ Log onto the VLE and share with your classmates the role low carbon development plays in your country. Is it being discussed by experts, policymakers, NGOs, firms and/or the public? If yes, in which ways? If not, why is that the case? Consider which elements of low carbon development are the most widely debated in your country and why and which one are less discussed and why. These elements could include, for example, strategies to reduce GHG emissions, increasing the share of renewable energy, emission trading schemes, protecting carbon sinks such as forests, wetlands and permafrost, improving people's understanding of climate change, behavioural changes of consumers, etc.

1.2 The need for low carbon development

Pages 3 to 7 and the introduction of the textbook *Low Carbon Development: Key Issues* explain how low carbon development is linked to global climate change and why low carbon development is needed.

There are two commonly used definitions of ***climate change***, one more narrowly defined by the United Nations Framework Convention on Climate Change (UNFCCC) and one more broadly defined by the Intergovernmental Panel on Climate Change (IPCC). The UNFCCC defines climate change as 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods' (UNFCCC, 1992: p. 3). The UNFCCC therefore makes a distinction between 'climate change', which is regarded as a purely ***anthropogenic*** phenomenon caused by human activities altering the composition of the atmosphere, and 'climate variability', which is attributed to natural causes (UNFCCC, 1992; IPCC, 2007). On the other hand, the IPCC (2007: p. 30) defines climate change as 'a change in the state of the climate that can be identified (eg using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity'. In this definition, the IPCC acknowledges that climate change has both natural and human causes; thus,

climate change may result from natural processes, such as variations in the Earth's orbit, as well as from anthropogenic changes, such as alterations in the composition of the atmosphere or of land-use patterns (Seinfeld & Pandis, 2006; IPCC, 2007; 2013).

The IPCC states that the 'atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800 000 years. CO_2 concentrations have increased by 40% since pre-industrial times, primarily from fossil fuel emissions and secondarily from net land use change emissions' (IPCC, 2013: p. 7). The concentrations of GHGs have increased rapidly, with concentrations of CO_2, CH_4 and N_2O exceeding the pre-industrial levels by about 40%, 150% and 20%, respectively, in 2011 (IPCC, 2013).

The IPCC has an extremely high confidence level of 95% probability that global climate change is anthropogenic, caused by excessive GHG emissions (IPCC, 2013; 2014). At the global scale, the atmospheric concentration of CO_2 has increased from a pre-industrial value of approximately 280 parts per million (ppm) to around 380 ppm in 2005 (IPCC, 2007) and a reported peak level of 396 ppm in 2007 (Richardson *et al*, 2009). In summer 2013, it was reported that the atmospheric concentration of CO_2 had even surpassed the **400 ppm** level at one stage (Tans & Keeling, 2013; Urban, 2014). Globally, annual emissions of CO_2 have risen dramatically in recent decades, reaching around 25 Gt (gigatonnes) of CO_2 in 2005, around 30 Gt in 2010 and almost 32 Gt in 2011 (IPCC, 2007; 2013). 'Increasingly, scientists agree that the possibility of staying below the 2 °C threshold by 2100 between "acceptable" and "dangerous" climate change becomes less likely as no serious global action on climate change is taken (Tyndall Centre, 2009; Richardson *et al*, 2009). A rise above 2 °C by 2100 is likely to lead to abrupt and irreversible changes (IPCC, 2007). These changes could cause severe societal, economic and environmental disruptions that could severely threaten international development throughout the 21st century and beyond" (Richardson *et al*, 2009; Urban, 2010)' (Urban & Nordensvärd, 2013: p. 4).

? What is climate change mitigation?

Answer

Climate change mitigation is defined as 'an anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce GHG sources and emissions and enhancing GHG sinks' (IPCC, 2001: 379). This definition stresses the importance of GHG emission reductions as well as the protection of GHG sinks such as forests, wetlands and permafrost.

Global climate change is not a distant vision of a troubled future, but very much a reality of today that requires urgent action. Former United Nations (UN) Secretary General and President of the Global Humanitarian Forum, Kofi Annan, mentioned a few years ago that 'Today, millions of people are already suffering because of climate change' (Annan, 2009: p. i). The UN Secretary General Ban Ki-moon confirmed recently on a trip to the small Pacific nation Kiribati that 'climate change is not about tomorrow. It is lapping at our feet – quite literally in Kiribati and elsewhere' (Ban, 2011: p. 1). Ban further said, 'I have watched the high tide impacting those villages. The high tide shows it is high time to act.' He also addressed the current development model and suggested

that something is 'seriously wrong with our current model of economic development' (Ban, 2011: p. 1).

In line with these comments, the textbook and a wide range of other academic literature argues that the current way of economic development is unsustainable and will lead to dangerous climate change, if no action is taken (Urban & Nordensvärd, 2013: p. 4). How low carbon development can be achieved will be discussed in the subsequent units.

✍ Read the key study materials by Grubb (2001) and Sorrell *et al* (2010)

— What are these two papers about?

— What are the main arguments the authors make?

— Referring to Grubb, how and why is there a need for climate change mitigation and transitions towards low carbon systems?

— Referring to Sorrell *et al*, how and why is there a need for transitions towards low carbon systems? What role does global oil depletion play?

— What future perspectives do these two authors see?

— How can climate change mitigation and low carbon development help solve these challenges?

Section 1 Self-Assessment Questions

(please also read the Key Study Materials to find the answers)

1 What are some of the observed impacts of global climate change? Choose one option.

(a) Increases in extreme weather events such as flooding and droughts in lower latitudes.

(b) Increases in extreme weather events such as flooding and droughts in higher latitudes.

(c) Increases in extreme weather events like flooding, storms, more frequent droughts and changes to atmospheric circulation.

(d) There are no observed impacts yet, but there may impacts in the future.

2 Fill in the missing words / phrases.

Low carbon development is a _____ model that aims to avoid dangerous _____ change. It follows the principles of _____ development, aims to increase the share of _____ _____ energy and adopts pattern of low carbon _____ and production.

3 Climate scientists estimate that for a 50% chance of achieving the 2 °C target, a global atmospheric CO_2 equivalent concentration of 400 to 450 ppm needs to be achieved (Richardson *et al*, 2009; Pye *et al*, 2010). To limit global warming to 2 °C by 2100 will require the following:

(a) An immediate reduction in global GHG emissions and a total reduction of 60–80% of emissions by 2100. This would require a peaking of global emissions by 2020 or earlier.

(b) A reduction in global GHG emissions after 2020 and a total reduction of 60–80% of emissions by 2100. This would require a peaking of global emissions by 2030 or earlier.

(c) A reduction in global GHG emissions after 2030 and a total reduction of 80–90% of emissions by 2100. This would require a peaking of global emissions by 2050 or earlier.

(d) It is too late to do anything.

2.0 THE ORIGINS OF LOW CARBON DEVELOPMENT

Section Overview

This section introduces the origins, concepts and key issues related to low carbon development and climate change mitigation. It discusses the links and interdependencies between climate change, GHG emissions and development.

Section Learning Outcomes

By the end of this section, students should be able to:

- understand the links and recognise interdependencies between climate change, GHG emissions and development
- critically discuss the origins and aims and limitations of low carbon development and climate change mitigation.

2.1 The origins of climate change mitigation

✍ Read pages 7 to 15 of the textbook *Low Carbon Development: Key Issues* to understand the origins of low carbon development, how it relates to climate change mitigation, international development, how the concept of low carbon development emerged and what needs to be done to achieve this low emissions development model. Pages 7 to 9 focus particularly on climate change mitigation.

Figure 1.1 (p. 7) shows a schematic overview of low carbon development, outlining its roots in climate change mitigation and international development. Please note low carbon development does **not** explicitly respond to climate change adaptation, although there may be co-benefits between the two. Low carbon development is primarily concerned with reducing GHG emissions leading to climate change and protecting GHG sinks, not with adaptation to the impacts of climate change, although this is equally important. To tackle climate change both adaptation and mitigation are required. The overlap between climate change adaptation and development is often referred to as climate-resilient development.

✍ Look at Figure 1.1 on page 7 of the textbook, which shows a schematic overview of low carbon development, and at Table 1.1 on page 9 which compares low carbon development and climate change mitigation. Re-read the text on pages 7 to 15. Then log onto the VLE and discuss with your classmates why it took such a long time before the climate community became interested in integrating development concerns in their agenda.

2.2 The origins of international development

✍ Read pages 9 to 10 of the textbook *Low Carbon Development: Key Issues* to understand the origins of international development.

From 2000 to 2015, the Millennium Development Goals (MDGs) were major milestones in international development that were hoped to be achieved by the international community. Post-2015, the **Sustainable Development Goals (SDGs)** are in place to cover the time frame between 2015 and 2030 and to achieve wider international development.

The SDGs explicitly incorporate energy and development targets as well as climate targets. The SDGs are embedded in the Rio+20 agenda on sustainable development, which followed the Rio+20 Earth Summit in 2012.

> *'Goal 1. End poverty in all its forms everywhere*
>
> *Goal 2. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture*
>
> *Goal 3. Ensure healthy lives and promote well-being for all at all ages*
>
> *Goal 4. Ensure inclusive and equitable quality education and promote life-long learning opportunities for all*
>
> *Goal 5. Achieve gender equality and empower all women and girls*
>
> *Goal 6. Ensure availability and sustainable management of water and sanitation for all*
>
> *Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all*
>
> *Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all*
>
> *Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*
>
> *Goal 10. Reduce inequality within and among countries*
>
> *Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable*
>
> *Goal 12. Ensure sustainable consumption and production patterns*
>
> *Goal 13. Take urgent action to combat climate change and its impacts**
>
> **Acknowledging that the UNFCCC is the primary international, intergovernmental forum for negotiating the global response to climate change.*
>
> *Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development*
>
> *Goal 15. Protect, restore and promote sustainable use of terrestrial*

ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss

Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development.'

Source: Sustainable Development Knowledge Platform (n.d. accessed 2014)

Relevant SDGs for low carbon development are goal 7 on energy and goal 13 on climate change, while most of the other goals address important issues that are indirectly relevant to low carbon development too.

✍ Re-read the text on pages 9 to 10 in the textbook. Then go to the website of the Sustainable Development Knowledge Platform (n.d.; available from the References listing) and read more about SDGs 7 and 13. Then log onto the VLE and discuss with your classmates why it took such a long time before the development community became interested in integrating climate change mitigation concerns in development pathways.

2.3 The emergence of low carbon development

✍ Read pages 10 to 15 of the textbook *Low Carbon Development: Key Issues* to understand the emergence of low carbon development, the benefits and opportunities of low carbon development and how to achieve low carbon development.

? What is decoupling of economic growth from carbon emissions and which types of decoupling exist?

Answer

Decoupling economic growth from carbon emissions requires that the emission growth rate is lower than the gross domestic product (GDP) growth rate.

***Absolute decoupling** requires an absolute cut in emissions. No absolute decoupling has been observed yet in relation to climate change (Sustainable Development Commission, 2009; Urban and Nordensvärd, 2013). In 2014, global CO_2 emissions stalled for the first time for 40 years according to the International Energy Agency. There is a clear link between economic growth and GHG emissions, and despite the stalling in one year, no decline has been observed yet. Both global GDP and global carbon emissions have strongly increased over the last 100 years (IPCC, 2007), suggesting it is very difficult to achieve absolute decoupling with the world's current development models (Urban and Nordensvärd, 2013).*

*'**Relative decoupling** means that more economic activity is possible with lower emissions. This is measured for example in carbon intensity or energy intensity, which is the amount of carbon emissions or energy used per unit of GDP. Relative decoupling in terms of carbon and energy intensity has been observed in a number of countries during the last few years. China and India for example have rapidly decreasing carbon and energy intensities (Van Ruijven et al, 2008; Urban, 2010)' (Urban and Nordensvärd, 2013: p. 12), while decreases in carbon and energy intensities have been made for several decades in the OECD countries.*

✍ Look at Figures 1.2 and 1.3 on pages 13 to 14 of the textbook. How do these graphs relate to absolute and relative decoupling? Now look at Figure 1.4 on the Environmental Kuznets Curve (EKC). Read the text on the EKC again and write down a few keywords or sentences to explain how the EKC and the decoupling of economic growth from GHG emissions are linked. Think about the following: According to the concept of the EKC, which trajectory should GHG emissions follow over time as countries develop? Can this be observed in real life? Why or why not? You may wish to log onto the VLE to share your thoughts with your fellow classmates.

Section 2 Self-Assessment Questions

4 How does low carbon development different from mitigation? Choose three options.

(a) The focus for low carbon development is on all GHG emitters with development needs, not only on major emitters as for mitigation.

(b) Low carbon development focuses more on climate finance than mitigation.

(c) The time perspective for low carbon development is more flexible, focusing on medium-term improvements too, rather than focusing mainly on long-term improvements as for mitigation (eg end of the 21st century).

(d) The main goal for low carbon development is to mitigate emissions by responding to development needs, rather than following a purely technical approach as for mitigation.

(e) Climate change mitigation is only relevant for the local level, while low carbon development is only relevant for the global level.

(f) Low carbon development can only be achieved with de-growth strategies while climate change mitigation needs economic growth to succeed.

5 Match the following statements.

(a) Combined efforts for climate change mitigation and development are called	(i) Low carbon climate-resilient development, also known as climate compatible development
(b) Combined efforts for climate change adaptation and development are called	(ii) Low carbon development
(c) Combined efforts for climate change mitigation, adaptation and development are called	(iii) Climate-resilient development

6 True or false?

Relative decoupling of economic growth from GHG emissions requires an absolute cut in emissions.

7 True or false?

The Environmental Kuznets Curve (EKC) is a concept that makes a correlation between environmental pollution and economic development. The EKC has the shape of an inverted U-curve. The hypothesis behind the EKC is that environmental pollution is at a low level when countries have very low income and development levels, then it increases and peaks when mid-levels of incomes and development are reached and pollution levels decrease again when income and development levels increase. This is based on the assumption that pollution levels will increase when developing countries industrialise; however, pollution levels will decrease again when countries become more prosperous and can afford to invest in pollution control technologies.

3.0 CHALLENGES FOR LOW CARBON DEVELOPMENT

Section Overview

The sections above explored what low carbon development is, why it is needed, its links to climate change and GHG emissions and its origins, as well as conceptual issues. This section highlights the challenges to its implementation and discusses low carbon development and climate change mitigation from a critical perspective. This section elaborates the relationship between economic growth and climate change mitigation efforts, trade-offs of low carbon development and a wider set of political, social, economic and technological barriers to low carbon development.

Section Learning Outcomes

By the end of this section, students should be able to:

- critically discuss the limitations of low carbon development and climate change mitigation
- understand with issues of economic growth and GHG emission reduction efforts, be aware of the trade-offs of low carbon development and the political, social, economic and technological barriers to low carbon development.

3.1 Low carbon development and the role of economic growth

✍ Read pages 15 to 16 of the textbook *Low Carbon Development: Key Issues* to understand the dilemma that economic growth poses for climate change mitigation and hence low carbon development.

✍ Read Professor Kevin Anderson's (Tyndall Centre and University of Manchester) commentary 'Avoiding dangerous climate change demands de-growth strategies from wealthier nations' (Anderson, 2013).

Anderson's main argument is that 'for a reasonable probability of avoiding the 2 °C characterisation of dangerous climate change, the wealthier (Annex 1) nations need, temporarily, to adopt a de-growth strategy.' (Anderson, 2013: p. 1).

Anderson's paper may make for an uncomfortable reading for some people, particularly those who are based in the wealthier nations that Anderson talks about. But, as he says, don't shoot the messenger: disliking a conclusion is not a good basis for disregarding it. What is underlying Anderson's argumentation is the widely accepted assumption that 'near-term development of poorer (non-Annex 1) nations should not be stifled by an overly constrained carbon budget.' (Anderson, 2013: p. 1). Before the Paris Agreement was put in place in late 2015, it took the global community nearly 20 years to agree on a successor to the Kyoto Protocol, precisely because of these positions in the UNFCCC climate change negotiations:

(1) The development efforts of poorer countries should not be hurt by emissions reductions is the strongly vocalised position of most developing countries, including many emerging emitters, and

(2) debates about economic de-growth and reducing excessive lifestyles are very uncomfortable and off-limits for most people in developed countries.

> *'Ockwell (2008) argues that* [absolute] *decoupling* [of] *growth from energy use is not possible because of the so-called rebound effect and the laws of thermodynamics. The rebound effect is an issue of consumer behaviour: money saved on energy (for example on using less electricity due to energy-efficient devices) is spent on other activities requiring energy (for example, petrol for going on holidays). The laws of thermodynamics are the mass-balance-principle and the entropy law. The mass-balance-principle predicts that energy cannot be created or destroyed, so energy will always be needed for economic activities and cannot be replaced by technology and manpower. The entropy law predicts that energy and materials will reach a lower quality once used as the quality of energy decreases with its use, while the entropy increases. To reach a higher state of quality (e.g. to recycle a material), energy will be needed again. As a consequence, energy is constantly needed for economic growth and decoupling is only restrictedly possible (Ockwell, 2008).'*
>
> *Source: Urban (2010) p. 87.*

> *'Barrett* et al *(2008) on the other side argue that decoupling is possible with energy-efficient technology and by replacing fossil fuel energy by low carbon energy such as renewable energy. While both Ockwell and Barrett mainly discuss about energy and decoupling, the issue is more complicated in relation to emissions and decoupling. The IPCC reports that energy-related activities – mainly from fossil fuel energy use – account for 70% of total greenhouse gas emissions (IPCC, 2007). For the issue of decoupling, fossil energy use and emissions are thus linear linked. To complicate this debate, recent research has shown that emissions from deforestation and land degradation also play a large role in climate change (Richardson* et al*, 2009). This means that while fossil energy use and emissions are linear linked, the issue of decoupling becomes much more complex and non-linear when emissions from deforestation and land degradation are taken into account.'*
>
> *Source: Urban (2010) p. 87.*

3.2 Trade-offs

✍ Read pages 16 to 17 of the textbook *Low Carbon Development: Key Issues* to understand the trade-offs of low carbon development, such as 'unintentional' low carbon economies, the severe social and environmental impacts of large hydropower dams and the allegations over land-grabbing for biofuels.

✍ Make a list of the positive impacts of low carbon development, such as mitigating global climate change, proving modern energy access to those living in energy poverty, the health benefits of reduced air pollution in lower carbon cities, etc.

Then make a list of the potential trade-offs or potentially negative impacts of low carbon development as discussed on pages 16 to 17 of the textbook. How can these trade-offs be avoided?

Finally, think about the 'whom' question: for whom is low carbon development relevant and at what scales? Who benefits from climate change mitigation at a global, national and local scale? Who benefits from particular low carbon projects (eg solar home systems, large-scale dams, electric vehicle charging stations, payments for afforestation, etc). When does the government benefit, when do private firms benefit, when does the local population benefit?

You may wish to log onto the VLE and discuss these issues with your classmates.

Jakob and Steckel (2013) argue that there may be risks, mainly of economic nature, associated with climate change mitigation in poor countries, such as increased energy prices that could disproportionately affect the poor, rising use of more expensive low carbon energy sources and a lack of investment in infrastructure. Jakob and Steckel (2013: p. 161) therefore argue that emission reductions alone should not be the goal in poor country, but that low carbon development should be promoted by focusing on 'human well-being while saving emissions'. These findings are broadly in line with the latest international climate policy.

The Paris Agreement on Climate Change that will come into force in 2020 requires all countries, developed countries as well as developing countries, to commit to mitigation actions. However, these are based on so-called Nationally Determined Contributions (NDCs), which are planned and implemented by each national government and take into account the development needs and priorities of each individual country. Therefore, developed and developing countries have outlined their climate change mitigation goals which may be as ambitious or as lax as is needed to ensure the development needs of all countries are met. This is useful for poorer countries who can focus on activities that reduce emissions while promoting other development needs, such as economic restructuring, afforestation, improving public transport, attracting foreign direct investment for low carbon technologies, etc. For developed countries, this may mean they have some leeway too, despite the need to urgently reduce emissions.

3.3 Political, social, economic and technological barriers to low carbon development

✍ Read pages 17 to 20 of the textbook *Low Carbon Development: Key Issues* to understand the political, social, economic and technological barriers to low carbon development.

With regard to economic barriers, major progress has been made since the textbook was published in 2013. 'The price of solar photovoltaic (PV) panels has decreased from about US$60 per Watt in 1979 to only about $2 per Watt in 2009 (IEA, 2010)' (Urban & Nordensvärd, 2013: p. 18). In 2014, the price of 1 Watt of solar power was down to US$1 and in 2016, the price of 1 Watt had sunk to about US$0.50, as solar industry experts report. This is a major breakthrough as in 2015 the break-even point had been reached for renewable energy, especially solar. Solar power is now cost competitive with fossil fuels and often even cheaper, despite the low oil price and excessive fossil fuel subsidies.

✍ Make a list of the current barriers that low carbon development faces and possible solutions to these barriers. What needs to happen to implement low carbon development at a larger scale at a faster rate?

Section 3 Self-Assessment Questions

8 What is the largest barrier to low carbon development?

(a) The main problem is that low carbon technology is not commercially available yet (eg wind, solar, hydropower technology).

(b) The main barriers to low carbon development are of social and political nature. Many low carbon technologies are readily available at cost-effective prices, but their large-scale introduction requires a rethinking of our economies and our lifestyles.

(c) The main barrier is that low carbon development is only relevant for high emitters.

9 Fill in the missing words / phrases.

Low _____ development has many _____ and opportunities, such as contributing to climate change _____, co-benefits such as the synergies between climate change mitigation and _____, providing modern low carbon _____ access, contributing to health _____ through reduced _____ pollution. Yet there are a series of potential _____ and barriers of political, _____ economic and technical nature.

Unit Summary

This unit introduced the topic of low carbon development and climate change mitigation. It introduced the origins, concepts and key issues related to low carbon development and climate change mitigation. It discussed the links and interdependencies between climate change, GHG emissions and development. This unit explained the need for low carbon development and it also highlighted challenges to its implementation, such as trade-offs, barriers and risks.

KEY TERMS AND CONCEPTS

For key definitions, see Box 1.1 on page 5 and Box 1.2 on pages 6 and 7 of the textbook.

FURTHER STUDY MATERIALS

Danish Institute for International Studies (DIIS) (2009) *Reducing poverty through low carbon development: Recommendations for development cooperation in least developed countries*.

Available from: http://pure.diis.dk/ws/files/57792/PB2009_nov_Reducing_poverty_low_carbon_development.pdf

A short briefing paper outlining the opportunities for poverty reduction through low carbon development in least developed countries. It focuses specifically on energy and agriculture.

Urban, F. (2010) Pro-poor low carbon development and the role of growth. *International Journal of Green Economics*, 4 (1), 82–93.

This paper conceptualises low carbon development and addresses the role of economic growth for achieving a low carbon transition.

Unruh, G. (2002) Escaping carbon lock-in. *Energy Policy*, 30, 317–325.

This article explores the climate policy implications of the arguments made in 'Understanding carbon lock-in' (Unruh, 2000), which posited that industrial countries have become locked into fossil fuel-based energy systems through path-dependent processes driven by increasing returns to scale. Carbon lock-in arises through technological, organisational, social and institutional co-evolution, culminating in what was termed a techno-institutional complex (TIC). In order to resolve the climate problem, an escape from the lock-in condition is required. However, due to the self-referential nature of TIC, escape conditions are unlikely to be generated internally and it is argued here that exogenous forces are probably required.

Jakob, M. & J.C. Steckel (2016) Implications of climate change mitigation for sustainable development. *Environmental Research Letters*, 11 (10), 104010.

Evaluating the trade-offs between the risks related to climate change, climate change mitigation as well as co-benefits requires an integrated scenarios approach to sustainable development. This paper outlines a conceptual multi-objective framework to assess climate policies that takes into account climate impacts, mitigation costs, water and food availability, technological risks of nuclear energy, and carbon capture and sequestration, as well as the co-benefits of reducing local air pollution and increasing energy security. This framework is then employed as an example in different climate change mitigation scenarios generated with integrated assessment models. Even though some scenarios encompass considerable challenges for sustainability, no scenario performs better or worse than others in all dimensions, pointing to trade-offs between different dimensions of sustainable development. For

this reason, the authors argue that these trade-offs need to be evaluated in a process of public deliberation that includes all relevant social actors.

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Unprecedented temperature levels mean more heatwaves, flooding, wildfires and hurricanes as experts say global warming is here and affecting us now.

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