Chapter 6

Biofuels and the bigger picture

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Introduction

6.1 The core of the ethical framework developed in this report is formed by a set of six Ethical Principles, the first five of which are prior requirements to be met in biofuels developments. In the previous chapter, we examined some biofuel-specific policies and made recommendations as to how these should be improved in keeping with the first five Ethical Principles. It is unlikely that a biofuel will meet all of our Ethical Principles to the desired extent just like that. Indeed, there are bound to be many cases where the need to meet the demands of one principle will conflict with the ability to meet the demands of another. Carefully designed policy is necessary to manage such conflicts in practice and to make sure that meeting one principle does not unduly compromise meeting the demands of others – a challenge to policy makers attempting to put our previous recommendations into practice.

6.2 In this chapter, turning to our final Ethical Principle, Principle 6, we take a step back from these specific policy issues related to biofuels. Principle 6 asks a broader question: Could there be a duty to develop biofuels once the other principles are met? This question cannot be answered without relocating the issues to a wider environment, both in policy terms as well as in terms of alternative technologies.

6.3 We start by looking at some broader questions which partly arise from our recommendations in Chapter 5, for example regarding the development of new biofuels through the use of biotechnologies. We then proceed to apply Principle 6. How could a duty to develop biofuels arise, and, in light of other pressures on public and private finances, which aspects need to be considered so that consistent and coherent decision making can be established? Answers to these questions cannot be given by recourse to biofuels alone, and Principle 6 therefore enjoins us to consider other, alternative technologies. In this chapter we thus sketch out how our ethical framework could be applied to other technologies and other related policy areas.

Biofuels and the 'perfect storm'

6.4 Chapter 1 of this report described the powerful drivers that have influenced investment in biofuel-related technologies:

- energy and fuel security;
- economic development; and
- climate change mitigation.

These motives catalysed policies that led to very rapid adoption of a limited range of approaches to biofuels development, which in turn resulted in negative impacts, some of which have arguably exacerbated rather than alleviated the problems that biofuels are intended to address. For example, direct and indirect land use change may contribute negatively to climate change and confound the sustainability of economic development.

6.5 The use of food crops and of land previously devoted to growing food crops for the production of biofuels was one factor linked to a rise in food prices, triggering the so-called 'food versus fuel' debate. However, other factors also contributed to food shortages, including yield instability due to extreme weather events, financial speculation and increased meat consumption in rapidly developing parts of the world. These factors form components of the 'perfect storm', which was described as follows by Sir John Beddington, the UK Government's Chief Scientific Adviser:

> "The growing global population coming out of poverty will create an increased demand for food which will need to be produced on not much more land, using less water, fertiliser and pesticides than we have historically done. Through the 21st century this is achievable, but must be tackled coherently with other global challenges of climate change and energy, food and water security. It is predicted that by 2030 the world will need to produce around 50 per cent more food and energy, together with 30 per cent more fresh water, while mitigating and adapting to climate change."[551]

6.6 Sir John goes on to pose four key challenges for policy makers and scientists:

- Can 9 billion people be fed equitably, healthily and sustainably?
- Can we cope with the future demands on water?
- Can we provide enough energy to supply the growing population coming out of poverty?
- Can we do all this while mitigating and adapting to climate change?

6.7 All four of these formidable challenges – plus the challenge of protecting basic human rights and maintaining ecosystem services – are linked in some way to the development of biofuels, as described in earlier chapters. Indeed, biofuels occupy a space where almost all the big challenges the world faces today converge. Because of the complexity and interrelatedness of these challenges, it is not possible to find optimal solutions by changing only one of the numerous variables that contribute to them, neither with regard to the underlying issues nor with regard to biofuels technologies. The key is to find combinations of policy and technology levers that can stimulate systemic shifts in orientation, profoundly altering the opportunities for biofuels developments and minimising their impacts on people and the environment.

6.8 Professor Raphie Kaplinsky of the Open University, UK, makes the point that in recent centuries the dominant source of technological innovation has been the US, Europe and a small group of predominantly north-east Asian middle- and high-income countries. He says: "Not surprisingly, this context for innovation and growth has led to an innovation trajectory...which increasingly favours the use of labour-saving technological progress, assumes high-quality and pervasive infrastructure and produces products for high-income consumers at a large scale."[552] He notes, however, the increasing role played by China and India in innovation and asks whether the different social technologies and institutional environments in these countries might result in different innovation trajectories.

6.9 We recognise the complexity of innovation patterns in the fossil fuel and biofuels industries and the powerful forces ranged against any major changes to the status quo. An important component of this resistance to change is the lock-in to current fuel production and distribution systems, with their associated investment in major facilities worldwide. In these circumstances, radical change is inevitably disruptive and can lead to unanticipated effects that are more damaging than the system being replaced, often resulting in apparently conservative policy approaches. The challenge becomes one of enabling change in a way that is flexible enough to allow adaptation if needed and at the same time powerful enough to shift current production systems.

6.10 We believe that there is a significant role for biofuels to contribute to some dimensions of energy security, in particular in the transport sector, as well as climate change mitigation by reducing fossil fuel consumption, particularly given the new scientific advances highlighted in Chapter 3

[551] John Beddington (2010) *Food, energy, water and the climate: a perfect storm of global events?*, available at: http://www.bis.gov.uk/assets/bispartners/goscience/docs/p/perfect-storm-paper.pdf.
[552] Kaplinsky R (2011) Schumacher meets Schumpeter: appropriate technology below the radar *Research Policy* **40**: 193–203.

(the hurdles to fulfilling this role have been described in earlier chapters under the first five of our Ethical Principles). The basis for this assessment is the energy available in biomass and the likelihood of being able to access it within a relatively short timescale. This is coupled with the medium-term requirement for transitional technologies that can work with current infrastructure to deliver renewable transport fuels during the transition to future more effective solutions, and a recognition of the likely longer term requirement for some liquid transport fuel for aviation and heavy goods haulage.

6.11 It is important to recognise that there remains uncertainty about the extent of the potential contribution of biofuels to climate change mitigation, the time frame within which it can be delivered, and the feasibility of alternative non-biofuels technologies that might contribute more effectively to resolving the problem. However, biofuels have an impressive potential range of production scales in that they can contribute on a national scale as seen in Brazil, as well as through small-scale local schemes. Thus, there are strong reasons to support biofuels developments that will, given an appropriate policy environment, comply with our Ethical Principles.

6.12 However, developing this appropriate policy environment will not be straightforward. There is a need to balance flexibility to incorporate new evidence and avoid lock-in to sub-optimal approaches against the stability required to encourage investment and support for longer term changes in energy supply systems. The benefits of stability include: a predictable, long-term policy strategy and consistent and clear regulation for industry and farmers; stable incomes; and a strong basis for decision making on investment and company strategy. On the other hand, the benefits of flexibility include: avoiding lock-in to inferior technology pathways; and enabling new development pathways to be built up so that new scientific discoveries can contribute on a level playing field to future expansion in biofuels use.

Some general considerations

The best use of current biofuels resources

6.13 This report has pointed to numerous ethical problems raised by current biofuels systems. However, as some mandatory policy is already in place, the current generation of biofuels technologies will continue to be used for some time. It is therefore important to achieve the best possible use of current biofuels resources. Choices among alternative technologies – bioethanol or biobutanol; sugar cane or corn? – carry important implications in a resource/money-constrained world and, in addition to ethical considerations, they should be based on a clear, explicit and logical approach.

6.14 There are many methods available for selecting between different technological options within the policy context. These methods usually rely on various criteria, some of which are explicit while others are implicit or simply not stated. In keeping with our ethical framework, we urge that all relevant criteria should be openly specified, so that decision making, which attempts to determine the 'best use' of resources such as biomass generally or biofuels specifically, is objective and transparent. One approach which has been increasingly used in UK Government departments has been the use of 'resource cost curves'. In the context of choosing options for mitigating global climate change, the criterion (or indicator) adopted has been net greenhouse gas (GHG) emissions savings per GBP invested or spent. This covers just one of the five dimensions captured in our Ethical Principles, but, of course, other criteria are possible.[553] The attraction of resource cost curves is that they not only show the relative cost of, for example, saving "one tonne of carbon" but also combine this with the magnitude of net savings that can be achieved by each option.

[553] Other criteria and approaches exist and have been applied elsewhere to the problem of determining the best use of biomass and biofuels resources; see, for example, work on this problem in Denmark in: Wenzel H (2010) *Breaking the biomass bottleneck of the fossil free society*, available at: http://www.concito.info/upload/arkiv_55_1791740804.pdf.

6.15 Such cost curves are helpful in decision making and they could serve as a model for a tool that captures elements of the evaluation in a transparent way. However, they do not make careful consideration and judgment superfluous. On the contrary, decisions cannot be left to simple mathematical calculations and models; they require judgments to be made on the balance of evidence and arguments that capture interrelated and complex dimensions, such as social and environmental impacts. We therefore urge investors and policy makers to refer to our Ethical Principles when assessing alternative biofuels options and to make their reasoning as explicit and transparent as possible.

Developing and encouraging new approaches to biofuels

6.16 As we have shown in Chapter 2, current biofuels production brings with it several ethical challenges. Chapter 3 gave a glimpse into the dynamic field of new biofuels development which tries to respond to these challenges. Major research activities are under way to find a technology that is successful regarding climate change mitigation, sustainable production, scalability and economic appeal. The field warrants some optimism: given sufficient encouragement, one or several of the new approaches could mature into a commercially attractive as well as ethically acceptable option.

6.17 However, there is a big discrepancy between the powerful targets and related penalties that are in place for currently used biofuels and the very few incentives or governance approaches for new technological methods for developing biofuels that would stand a better chance of complying with our Ethical Principles. For example, there are no technology incentives in the Renewable Energy Directive (RED) or Renewable Transport Fuels Obligations (RTFO) even though new technologies from several research directions, including biotechnologies for genetic improvement, may be among the best options to mitigate global climate change through development of biofuels technologies that comply with our Ethical Principles.

6.18 While we have argued in this report that none of the new approaches is perfect and each is associated with inherent uncertainty, we take the view that it is important to recognise their potential positive attributes. Dismissal of this potential based on avoidable problems would be to 'throw out the baby with the bath water'.

6.19 Box 6.1 presents the three approaches we have discussed in Chapter 3 as scenarios. These scenarios are deliberately positive – i.e. whereby the technologies could achieve our main objective in that they have the potential to comply with our Ethical Principles, and practical challenges or tensions with at least some of our Ethical Principles are avoidable, for example through governance-related safeguards and optimum development of infrastructure. The scenarios are illustrative; we use them here as examples of how we can look at production options in the light of ethical considerations and design processes accordingly. From our previous discussions it is also clear that, even if they deliver, they cannot be applied in all regions and in all contexts. Thus, they should also be taken as illustrations of which elements we could use in a future *mix* of biofuels options.

Box 6.1: Three potential positive scenarios

Biofuels from residues

Production of lignocellulosic biofuels from agricultural residues left over from food crops presents several potential advantages from the perspective of the first five Ethical Principles. It is difficult to envisage how use of residues might impinge on people's essential rights that are described in Principle 1 (health, well-being, food and water security, and land entitlement); indeed, use of such residues could limit the amount going to landfill which is itself associated with pollution and adverse health impacts – a contribution to satisfying Principle 2 (environmental sustainability). Since no additional land other than the land used for the production of the original food crops is required, there would be no greenhouse gas (GHG) emissions from land use change for biofuels production. Furthermore, there is a significant opportunity for domestic production of lignocellulosic biofuels from agricultural residues, and also local small-scale production given the advent of decentralised production facilities. This too would help in delivering net reductions in GHG emissions and avoiding contributions to climate change as required by Principle 3 through a reduced need for transporting residues. Novel biotechnological approaches, including genetic modification, are expected to improve digestibility of lignocellulose

and to deliver significant cost reductions and improved efficiency in future commercial applications.

Since this is still a developing approach to biofuels production,[554] it would be possible to steer industry so as to comply with comprehensive sustainability standards and trade principles that are fair, and to ensure the equitable distribution of costs and rewards between stakeholders – for example by supporting local production of biofuels from residues and waste.

Biofuels from dedicated energy crops

The use of dedicated energy crops for biofuels production could also fare well against our Ethical Principles. Perennial crops potentially have high energy-conversion ratios – i.e. high yield with minimum inputs – which is a crucial characteristic for a biofuels feedstock. There is potential for developments in this area to diversify the agricultural landscape by introducing different types of plant and entirely different cropping systems. The different cropping systems will benefit biodiversity as well as decrease erosion and run-off, supporting Principle 2, and could provide options of new and more sustainable, diverse agro-ecosystems. The use of advanced plant breeding or genetic modification techniques could furthermore enhance traits via the ability to develop crops with maximised yields per area of land and reduced fertiliser, pesticide and water requirements. Such developments would deliver additional GHG emissions savings, satisfying Principle 3. If successful, they would also reduce the need for agricultural resources such as fertile land and water that are usually required for growth of food crops, thus sidestepping harmful impacts on food security. A reduced need for water would also help avoid threats to water security. All of this contributes to meeting the requirements of Principle 1. The developments that increase the energy-conversion efficiency of plants could help achieve environmental sustainability and GHG emissions savings for this method of biofuels production, satisfying Principles 2 and 3. Other aims of advanced plant breeding or genetic improvement approaches include improved ease of harvesting and storage and enhanced suitability for processing (an aim that could also be achieved through the development of genetically modified microbes), and these too would help to contribute to the overall environmental sustainability of this method of biofuels production (Principle 2).

Again, as this is a nascent industry, there are opportunities for regulation that would help to ensure protection against human rights violations, and enable just reward and equitable distribution of costs and benefits, for example through benefit-sharing schemes. A transition of this currently high-tech and high-cost technology to a routine processing approach could be helped by public–private partnerships or, within programmes of development aid, by enabling poorer countries to gain access to the novel technologies. Again, it will be important to ensure that comprehensive sustainability and social standards are in place.

Biofuels from algae

The potential to improve biofuel yields from algae is significant owing to the great genetic variety of the source material. Biotechnological options (including synthetic biology) are proposed to be able to deliver the necessary improvement in relevant traits, although estimates of the necessary timescale vary from five to 20 years. Higher biofuel yields – genetically modified or otherwise – would impact favourably on environmental sustainability, as demanded by Principle 2, given appropriate safeguards against the risks that may be entailed in any novel technological approach. Algal-based biofuels production is still in its infancy and therefore, again, there is the chance to develop production facilities designed with environmental and social sustainability in mind. For example, plants could be positioned near a power plant and/or water-cleaning works since algae are able to use wastewater as a source of nutrients and combustion gas as a carbon dioxide source. In addition, algae produce a variety of fuels and co-products, making them highly suitable for incorporation in a biorefinery model, contributing to environmental sustainability and net GHG emissions savings, supporting Principle 3. Algae would require a land base on which to site production facilities but there is no need for this to be fertile land: indirect threats to food security through land competition would thus be reduced. As with the previous approaches outlined, the early stage of development of the industry could enable appropriate safeguards to be incorporated to satisfy Ethical Principles 4 and 5. Particularly relevant here would be regulations to protect the right to just reward, including covering intellectual property as it relates to algal species.

To satisfy our ethical framework, the fast-growing algae industry needs ethical safeguards incorporating our Ethical Principles. In particular, these should try to ensure that any benefits that do materialise strike an appropriate balance between equitable cost–benefit sharing and justified profit by those who invested in algal research and development. Access and benefit-sharing schemes will be central to achieving this balance.

6.20 **We recommend to research councils that specific policies be developed and implemented that directly incentivise research and development of new and emerging biofuels technologies that need less land and other resources, avoid social and environmental harms in production, and deliver significant greenhouse gas emissions savings.**

[554] Some countries, for example Germany, have been producing biofuels from agricultural residues for some time now, but in most other countries this is still a new approach.

Using modern biotechnology

6.21 As these three scenarios show, using modern biotechnology to improve crops and feedstocks is a potentially productive option to enable the development of biofuels that could directly and positively contribute to Principles 1 (human rights), 2 (environmental sustainability) and 3 (climate change). There are also expected benefits from the use of genetic technologies to produce improved or cheaper enzymes to enhance the efficiency of digestion of lignocellulosic biomass. For example, both yeasts and bacteria are being genetically modified to improve fermentation of biomass while withstanding high ethanol concentrations, which increase as the fermentation process proceeds. Alternative approaches aim to develop microorganisms that enable sidestepping the expensive and energy-intensive step of distillation; other examples are using genetically modified microbes to produce biodiesel from sugars or from syngas. Technologies for genetic improvement, including advanced plant breeding strategies and other process-based approaches, have the potential to contribute to mitigating global climate change, to meet the practical challenges addressed in this chapter, to comply with the demands of our Ethical Principles, and to alleviate some of the factors contributing to the 'perfect storm'. However, it is important to consider the cost–benefit relationship using a transparent,[555] evidence-based approach for each proposed technology-based system.

Proportionate regulation for modern biotechnology

6.22 A proportionate risk governance approach for innovative technology has been described as symmetrical to the risks and benefits to individuals and society, allowing for different applications depending on the context.[556] It should be evidence-based, enabling of innovation, minimising risk to people and the environment, and balancing the interests and values of all relevant stakeholders, avoiding simplistic comparisons across sectors and technologies.

6.23 By these standards, some argue that the governance system currently in place for genetically modified plants that could contribute to meeting our Ethical Principles is increasingly inappropriate. The European regulatory system for crops produced using genetic modification is more complex, time-consuming and expensive to implement than that for any other agriculture-related technology. There is evidence that crops produced using genetic modification do not carry any higher risks than those produced by other methods. For example, the effects of different herbicide regimes on insect biodiversity showed that the more effective the regime was in reducing weed diversity and numbers, the bigger the impact on insect biodiversity, regardless of whether the herbicide regime involved genetically modified herbicide-tolerant crops or conventional crops.[557] Indeed, there is evidence of the ability of genetically modified crops to contribute positively on balance to sustainable development, including economic, environmental and societal sustainability, although with some qualifications, as with all complex agricultural systems.[558]

6.24 A recent report from the UK Advisory Committee on Releases to the Environment, developed in response to the inconsistencies in the regulatory assessment of the environmental impact of genetically modified crops in comparison with other agricultural crops and practices, has

[555] This means, for example, that the data on which the decision for a particular biotechnology is made are publicly available and the chain of analysis can be replicated by others.

[556] Academy of Medical Sciences (2011) *A new pathway for the regulation and governance of health research*, available at: http://www.acmedsci.ac.uk/p99puid209.html.

[557] Farmscale Evaluations Research Committee and Scientific Steering Committee (2005) *Managing GM crops with herbicides: effects on farmland wildlife*, available at: http://webarchive.nationalarchives.gov.uk/20080306073937/http://www.defra.gov.uk/environment/gm/fse/results/fse-summary-05.pdf.

[558] Park TR, McFarlane I, Hartley Phipps H and Ceddia G (2011) The role of transgenic crops in sustainable development *Plant Biotechnology Journal* **9**: 2–21.

advocated proportionate comparative assessment of the risks and benefits of all novel agricultural systems, whether or not genetically modified crops are involved.[559]

6.25 In the context of biofuels development, regulatory systems are appropriately restrictive for what is called 'industrial biotechnology', for example where microorganisms such as algae are grown in contained conditions to produce biofuels. However, for plants grown outdoors, innovation is being restricted rather than enabled by the national and regional regulatory systems in force in Europe and increasingly in some other parts of the world, and particularly by the United Nations Convention on Biodiversity[560] and the associated Cartagena Protocol on Biosafety.[561] Although developed with the best of intentions at a time when there was much more uncertainty around the potential risks and benefits of genetically modified plants, these regulatory systems may no longer reflect recent evidence on risks in practice. These instruments could usefully be reviewed to assess whether and how they could contribute positively to the potential of modern biotechnology to meet the requirements of our Ethical Principles.

6.26 **We propose that, in order to address our Ethical Principles effectively, some modifications might be needed to existing policies and regulations related to new crop developments for agriculture and forestry. This might require some modifications to international agreements. Evidence-based and proportionate review of these policies should take place as soon as possible.**

Implementing Principle 6

6.27 Having looked at human rights, environmental sustainability, climate change, just reward and equitable cost–benefit distribution through Principles 1–5 and some general issues regarding the use of biomass and novel technologies, how do we determine whether there is a responsibility to develop biofuels? In today's world, is there an ethical duty to develop biofuels?

6.28 Our Principle 6 (Box 6.2) is proposed as a *duty not to do nothing*, to bring action forward, in cases where the other five Ethical Principles are either not violated or could be satisfied through appropriate governance mechanisms, *and* where (subject to the additional considerations) biofuels can enable us to fulfil our responsibility to mitigate climate change.

Box 6.2: Principle 6

If the first five Ethical Principles are respected and if biofuels can play a crucial role in mitigating dangerous climate change then, depending on additional key considerations, there is a duty to develop such biofuels.

These additional key considerations are:

- absolute cost consideration;
- alternative energy consideration;
- opportunity cost consideration;
- uncertainty consideration;
- irreversibility consideration;
- participation consideration; and
- proportionate governance consideration.

6.29 This is especially important in terms of the value of the common good. Reducing human-generated GHG emissions is in the long-term interests of those living now and those yet to be

[559] Advisory Committee on Releases to the Environment (2007) *Managing the footprint of agriculture: towards a comparative assessment of risks and benefits for novel agricultural systems*, available at: http://webarchive.nationalarchives.gov.uk/20080727101330/http://www.defra.gov.uk/environment/acre/fsewiderissues/pdf/acre-wi-final.pdf.
[560] Convention on Biological Diversity of 1992.
[561] Cartagena Protocol on Biosafety to the Convention on Biological Diversity of 2000.

born. Doing nothing offends directly against the common good. Reducing these emissions is not simply good stewardship, although that is important; it is a duty deriving from the common good.

6.30 A duty to develop biofuels that meet the standards of Ethical Principles 1–5 cannot be an unconditional one. Meeting the standards required by our first five Ethical Principles is but the first step in establishing whether a biofuels technology should become an ethical imperative and can be adopted widely. Principle 6 affirms that the existence of a duty depends on whether 'additional key considerations' are met. These relate to the efficient, effective and equitable use of resources and technology, and need to be assessed for any technology before it is considered for wide implementation:

- The 'absolute cost consideration' would rule out a development where the costs are out of all proportion to the benefits, compared to other major (public) spending priorities such as, for example, health or housing.
- The 'alternative energy sources consideration' would require investigations on whether there are competing energy sources that might be even better, for example at reducing GHG emissions, while still meeting all the required Ethical Principles.
- The 'opportunity cost consideration' would rule out a development where there is an alternative and better use of the biomass feedstock, for example as feedstock for higher value products from the chemical industry.
- The 'uncertainty consideration' would focus attention on the areas of uncertainty in the development and implementation of a technology, and incentivise efforts to reduce them.
- The 'irreversibility consideration' would help avoid the implementation of technologies that lead to irreversible consequences and damage, once they are scaled up. It would also contribute to evading the danger of a 'lock-in' to inferior technology solutions.
- The 'participation consideration' would ensure that fair attention is paid to the voices of those directly affected by the implementation of a technology.
- The overarching 'proportionate governance consideration' would rule out inflexible 'one size fits all' approaches to policy and make sure that policy instruments can be applied in a proportionate way symmetrical to the specific risks and benefits involved.

6.31 In relation to 'alternative and better uses' of biofuels themselves or of financial resources, it is important to bear in mind the urgency of the problem of global climate change and the need to use every available means to tackle it. From a policy and economic perspective, the question is not always "Do A or B?" but can also be "How can both A and B contribute together to mitigating global climate change?"

6.32 The practical parameters to be considered when assessing whether a biofuels technology meets these conditions are captured in a number of questions, for example:

- How effective is the biofuels technology – can production be scaled up sufficiently so that it makes a difference?
- What cost is involved – will the technology deliver a favourable return in a reasonable time frame?
- Is the potential for revenue big enough to interest industry stakeholders and investors?
- Can policy help to bridge the gap between the high-cost development stage and commercialisation, and if so how?

- What is the degree of uncertainty involved in the development and scaling up of this technology, and how could it be reduced?
- Will the implementation and scaling up of the technology result in irreversible consequences, and, if so, how could this be avoided?
- Have those directly affected been involved sufficiently in the decision-making process?
- Can policy instruments be applied in a proportionate way?

6.33 Answering these questions in the context of the considerations of Principle 6 should be part of a comprehensive comparative analysis of all different future energy and climate change abatement options, including comparison of energy *portfolios* with a different mix of technologies, since one technology might, for example, mitigate the disadvantages of another within a mix, or, instead, augment them. In fact, our ethical framework, as well as the questions we draw from them above, could serve as a template or a benchmark against which the ethical robustness of a range of possible pathways can be assessed. It could be a yardstick to hold up against a range of options to decide which is most appropriate in the future – a checklist of ethical appropriateness.

6.34 Moreover, this applies retrospectively as well. First and foremost, this template is, of course, about asking whether a particular technology should be pursued, but it is arguably equally valid to use the same template for ethical assessment of the governance mechanisms that are in place once it has been pursued and is being introduced and developed/implemented. Such evaluations across different technology pathways are challenging but are, we believe, necessary in order to make the complex comparisons between alternative technology options.

6.35 After careful consideration of all items on the checklist, going through Principles 1–5 and asking the questions which flow from Principle 6, we should be in a better position than we are today to make ethically based policy decisions. Put simply, if a technology, or a particular mix, meets our Ethical Principles 1–5 and has a positive evaluation under the additional considerations of Principle 6, then there is a duty to develop it.

6.36 **We suggest that UK and EU policy makers as well as those in the research community conduct comparative analysis of different energy portfolios rather than simply different technology options.**

6.37 **We encourage UK and EU policy makers undertaking comparative analyses of the impacts of different energy and climate change abatement technology options to apply our Ethical Principles 1–6 as a template or benchmark against which the ethical robustness of a range of possible pathways can be assessed when engaging in policy and technology appraisal.**

6.38 **If a biofuels technology, or a particular mix, meets all elements of our Ethical Principles 1–6 then there is a duty to develop it.**

An approach to support Ethical Principles 1–6

6.39 The systemic nature of the ‘perfect storm’ was outlined at the beginning of this chapter, and we have also emphasised the need for appropriately systemic responses, in particular seeing policy and governance approaches as necessary contributors to meeting the requirements of our Ethical Principles. To support effective policy making, we propose that these elements be seen as part of a coherent approach that incorporates these Ethical Principles alongside governance and regulatory components. Internationally traded products, based on contentious and sometimes unethical production processes in agriculture and forestry, have historically been resistant to policy-induced change, and it would be naïve to overestimate the power of one report to effect such change. Our aim here is to suggest an approach that brings together insights and recommendations based on our Ethical Principles, as a contribution to future policy

decision making, nationally and internationally, in the expectation that it will reinforce other related initiatives and facilitate the desired changes.

6.40 Ideally, biofuel-specific instruments such as standards and certification would be embedded within wider policy instruments in international production and trade policy related to:

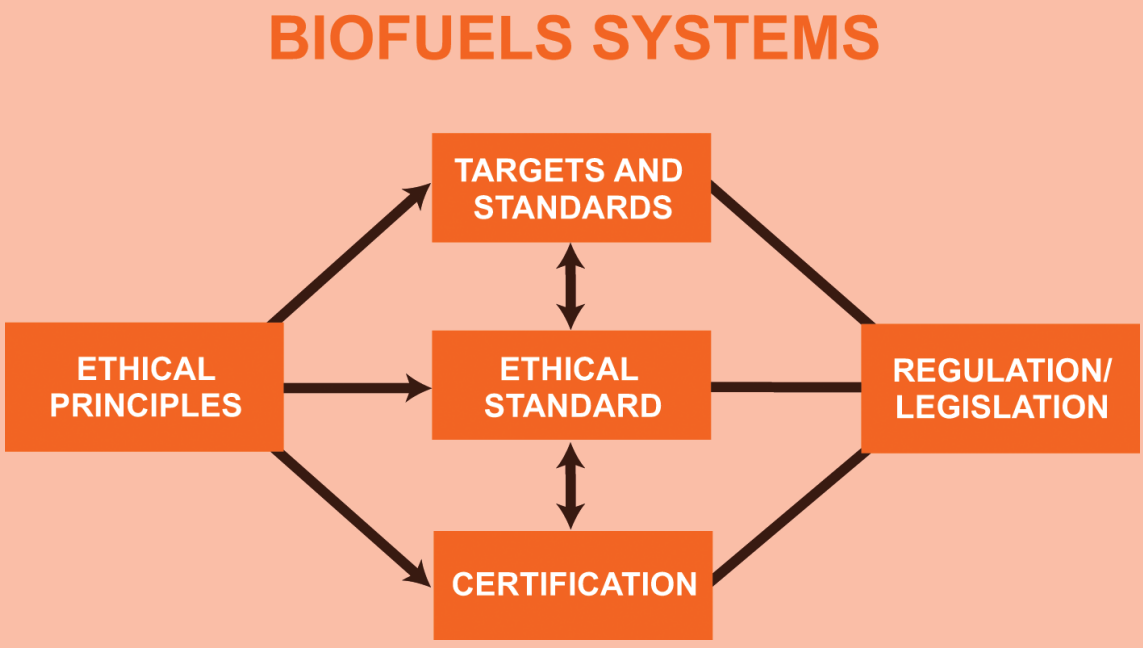
- environmental sustainability for agriculture;
- international agreements on climate change mitigation;
- land use and zoning policy; and
- safeguards to protect human rights, just reward and the equitable distribution of harms and benefits.

6.41 In the previous chapter, we mentioned some instances where such integration would be particularly desirable and made recommendations where we believe that some biofuels-related problems should be dealt with through changes in existing policy. The most important example of this is our suggestion that the best way to deal with the problem of indirect land use change is to tackle land use change as part of a wider framework of global agreement on a coordinated response to climate change.

6.42 However, changing the broader policy landscape to support the ethical development, production, use and trade of all agricultural and related products is beyond the scope of this report. If the difficulties experienced in reaching global agreement on climate change policies are any indication, it will require coordinated and sustained effort to shift the relevant policy fields towards more ethical practices and to ensure their effective implementation and oversight. In the meantime, several ethical issues related to biofuels require immediate attention.

6.43 Box 6.3 outlines elements of a proportionate governance approach, the central features of which, alongside our Ethical Principles, are standards, targets, certification schemes and regulatory systems.

Box 6.3: Proportionate governance approach



6.44 Current biofuels targets, such as the RED target, have contributed to the rapid adoption of sometimes inferior biofuels production and have thus indirectly led to some of the ethical issues discussed in earlier chapters. Targets of the type used in the RED are very blunt instruments, and we believe that the incentivising of a particular technology development should be more sophisticated and responsive.

6.45 Besides the bluntly successful incentivising of production, targets have one major advantage: if stable and consistent, they provide a reliable planning framework for those involved in development and production of biofuels, in particular for farmers and industry. We believe that a long-term view is important in biofuels policy; however, targets also need to be realistic. It is highly likely that most EU Member States will fail to fulfil the current RED target. Targets also have to display a sufficient degree of flexibility to reflect the significant uncertainty in the biofuels area, as well as its heterogeneity and the complex, international interplay between many different stakeholders. Most importantly, within an approach underpinned by strong Ethical Principles, targets should enable appropriate reaction to any of their problematic unintended consequences. We therefore suggest that current RED and national biofuels targets be replaced with an alternative strategy, also target based, that continues to drive forward change, but in a more flexible, nuanced and responsive way.

6.46 **We recommend that policy makers at the European Commission level and in Member States replace current Renewable Energy Directive and national biofuels targets with an alternative, proportionate, target-based strategy that is in accord with our Ethical Principles and that drives change in a more nuanced, flexible and responsive way.**

6.47 Biofuel-specific standards and certification schemes, continually improved, will be important instruments of change in biofuels developments. They will be most effective if they are accompanied by elements from regulatory systems, for example financial sanctions, and incentives such as subsidies or assured markets where specific standards are met. However, so far, despite the best intentions, the outcomes of such initiatives have not been entirely positive. Our policy recommendations refer to the need to use these instruments intelligently to effect improvements in biofuels systems, and this requires continuing monitoring of impacts.

6.48 **We suggest the development and implementation of a comprehensive ethical standard for biofuels, to include the protection of human rights and the environment, full life cycle assessment of greenhouse gas emissions, trade principles that are fair, and access and benefit-sharing schemes. It should be set within wider frameworks for mitigating climate change and addressing land use change (direct and indirect), and should be open to future revision as needed.**

6.49 Standards need to be enforced, and the instrument of choice to ensure this is certification. There is a clear requirement for certification already built in to the RED. For the most part, this now sits with Member States, which have been called upon to develop national certification schemes. Fuel suppliers are making preparations for compliance with the associated national regulations. The differences in requirements among Member States have already resulted in operational and administrative challenges; compliance, for example, is complex when certification requirements vary across the EU. Certification, as it is envisaged here, implements our Ethical Principles, which should ideally apply across all EU Members States, if not globally, with accompanying efforts in monitoring its impacts.

6.50 **The ethical standard for biofuels should be enforced through corresponding certification for all biofuels developed in and imported into the EU. We recommend that, instead of voluntary schemes developed by each Member State, a unified certification scheme be developed and implemented. Such certification should allow for proportionate application, for example in the case of local small-scale biofuels production. The EU should provide financial support and advice to countries who might find it difficult to implement such certification.**

Why just biofuels?

6.51 We have suggested above that a comprehensive standard should be applied to biofuels production through certification. However, several elements of the standard and the associated certification scheme should ideally be applied equitably to all similar products and not just biofuels. There is no reason why our ethical framework and its Principles should apply to just one sector of agricultural and technological activity. In particular, the considerations flowing from Principle 6 apply to many technologies and activities, not just to biofuels. Indeed, there is a risk that in putting barriers (i.e. ethical conditions) in the way of biofuels development, this could inhibit their development, while the Principles we have developed continue to be violated in other agricultural, energy generation or trade practices. We therefore propose that our Ethical Principles be used as a model or benchmark in *all* comparable technologies and products, taking one important step towards the development and improvement of the wider policy context that is needed to tackle the enormous challenges of the future. This implies a very ambitious and challenging prospect for those devising and implementing the necessary policy instruments. However, we should attempt to go as far as possible along the way to meeting relevant standards in the context of global climate change.

6.52 **We recommend that our Ethical Principles be applied, ultimately, as a benchmark to all comparable technologies and products.**

Bringing it all together

6.53 The focus of this report is on biofuels because of ethical concerns that have arisen as a result of the very rapid adoption of early generation biofuels. The biofuels focus, while pragmatic, might be potentially problematic. As described in earlier chapters, biofuels are only a small part of both energy and agricultural policy. However, it is important to emphasise that the principles we have developed are much more widely relevant and can – and should – be applied across the board.

6.54 Despite the fact that biofuels will, in all likelihood, constitute a small contribution towards overall world fuel use, this is nonetheless an important contribution. In the increasingly heterogeneous fuel and energy portfolios of the future, each contribution from a sustainable liquid fuel source will be meaningful.

6.55 With respect to energy policy, as stated in the Introduction, reduction and decarbonisation are key priorities. However, biofuels have a role to play during the transition to other solutions. Furthermore, it is likely that biomass will continue to be important for replacing other fossil fuel derived products, such as plastics, even after the fuels themselves have been superseded. The ethical framework we propose will continue to be useful both in assessing other fossil fuel replacement solutions as they emerge, and in assessing biomass feedstock production for other purposes.

6.56 Similarly, agricultural production of feedstock for biofuels must be considered in the light of wider agricultural and trade policy. There are many competing uses for land including the production of food, clothing (e.g. cotton), building materials (e.g. wood) and fuel, as well as the provision of ecosystem services. There is increasing pressure on all these resources as the world population increases, and, here again, reducing waste and excessive consumption, along with decarbonisation of the supply chains, are priorities. The framework we have developed for biofuels can be used in this wider context to promote optimal land use in any one situation, and equitable distribution of the benefits of such use.

6.57 This chapter has reinforced the point that there is no single solution to the primary question for this report – enabling biofuels to contribute, as appropriate, to mitigating the ‘perfect storm’ while also complying with our Ethical Principles.