**Additionality of climate change mitigation activities**[1]

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Abstract

Although widely considered to be a core aspect of quality assurance of climate change mitigation activities, additionality remains a source of much controversy in relation to carbon accounting and carbon markets. This chapter illuminates the multi-faceted nature of the concept and develops a taxonomy of different forms. It provides an overview of how additionality is currently applied in relation to both compliance and voluntary carbon markets, including tests used and underlying evidence base requirements. This draws upon and updates an earlier review commissioned to help inform development of a Woodland Carbon Code designed to underpin climate change mitigation activities in the UK by the forest sector. Sources of uncertainty and trade-offs in practical application of the concept are highlighted, and potential perverse incentives explored.

## 1. Introduction

The concept of additionality is used to distinguish the net benefits associated with an activity or project by comparison with what would have happened in the absence of the intervention (HM Treasury, 2003). In a climate change mitigation context, additionality is generally used to mean net greenhouse gas (GHG) emissions savings or sequestration benefits in excess of those that would have arisen anyway in the absence of a given activity or project (i.e. compared to a 'baseline').

Along with issues of permanence, leakage and displacement, additionality is widely considered a core aspect of quality assurance of climate change mitigation activities. Lack of additionality implies there are no GHG abatement benefits over and above those that would have arisen anyway. Credits issued for benefits which are not additional but are used as offsets result in an overall increase in GHG emissions. They would not provide net abatement benefits to those who purchase them, and would undermine wider climate change mitigation efforts. The requirement for climate change benefits to be 'additional' is reflected at international level in Articles 3.4, 6.1, and 12.5 of the Kyoto Protocol.

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Additionality remains a source of much controversy in relation both to carbon accounting and carbon markets. This relates in part to the hypothetical nature of counterfactuals (i.e. identification of what would have otherwise occurred) upon which baselines and additionality determination are based (e.g. Schneider, 2007; McCully, 2008; Wara and Victor, 2008; Shapiro, 2010). It also relates to concerns that additionality criteria can provide perverse incentives to invest in relatively high-cost projects that offer comparatively few climate benefits (e.g. Bode and Michaelowa, 2003), or even in projects that increase GHG emissions (Mukerjee, 2009; Calel, 2011). To the extent that the concept encompasses a range of wider environmental, institutional and social considerations that have no direct connection to GHG balances per se but relate to broader criteria for judging the value of abatement activities, the scope of additionality (i.e. which of the wider aspects are included) can also be controversial.

## 1.1 Structure

Focusing upon project additionality, this article explores the multi-faceted nature of this concept (for discussion of international finance additionality, see: Brown et al., 2010). It builds upon a review (Valatin, 2011) commissioned to help inform development of the Woodland Carbon Code (Forestry Commission, 2011b) designed to help underpin climate change mitigation activities by the UK forestry sector.

Drawing upon existing protocols, the next three sections develop a taxonomy of different forms of environmental additionality, legal, regulatory and institutional additionality, and financial and investment additionality. These forms are treated as distinct for the purposes of developing the taxonomy, although some are closely linked, and in practice distinctions are sometimes blurred and different forms combined within a single test.

The article then provides an overview of how additionality is currently applied in practice in both compliance and voluntary carbon markets, including explicit tests and underlying evidence requirements for forestry projects. This is based upon reviewing material on approaches to additionality published on the websites of the different carbon standards without prejuding coverage of the concept.

The article then considers how some additionality tests can give rise to perverse incentives. Such concerns have arisen in a wider context, especially in relation to Certified Emissions Reduction credits (CERs) issued for trifluoromethane (HCF-23) destruction projects implemented under the Clean Development Mechanism (CDM) of the Kyoto Protocol (Rajan, 2011; Schwank, 2004; Schneider, 2011a,b). Analysis of how perverse incentives could potentially arise in relation to woodland carbon projects draws upon a modified version of the additionality game developed by Calel (2011) in the context of HCF-23 projects. A final section offers some conclusions. Readers preferring to skip details of the taxonomy or current approaches can find summary information on these in Table 7, and in Tables 2 and 3, respectively.

## 2. Types of additionality

### 2.1 Environmental additionality

Environmental aspects are fundamental to determining the additionality of GHG abatement projects. At least six forms can be distinguished.

#### 2.1.1 GHG additionality

A key component in quantifying abatement savings, GHG additionality relates to comparisons with a baseline level of emissions. The net impact of a project on GHG balances fundamentally depends upon the breadth of carbon pools and other GHG fluxes taken into account in determining the baseline, emissions and sequestration. In some cases a narrow focus may be taken on carbon fluxes associated with above-ground vegetation only. In others, account may also be taken of below-ground carbon pools including soils, storage in harvested wood products, and displacement effects of using wood products instead of fossil fuel and more fossil fuel intensive materials. Covering a wider range of impacts can be expected to improve the quality of additionality assessments providing reliable quantification methods are available, but also increase the cost.

The time horizon used to judge GHG additionality can also be important, as well as any explicit or implicit weighting system used in comparing GHG emissions and savings at different points in time. Where projects increase household incomes, ‘rebound effects’ of GHG emissions associated with higher incomes and energy use may also be taken into account. In some cases, the baseline may take account of alternative investment options, rather than purely projections for the project area in the absence of the project going ahead.

The net impact also depends upon the method used to determine the baseline. This may be established using a project-by-project (‘bottom-up’) approach, or using a standardised or benchmarked (‘top-down’) approach. Better able to take account of specific project attributes and site conditions, a project-by-project approach can be more precise. By contrast, a standardised or benchmarked approach has the advantage of reducing project-specific transactions costs (Bloomgarden and Trexler, 2008), with project activities simply considered additional in some cases if they are of a particular type included on a ‘positive list’ (Peters-Stanley, 2012).

#### 2.1.2 Unit additionality

To prevent what are considered ‘business as usual’ activities being credited and to promote efficient resource use, projects may only be considered additional where their output is associated with emissions per unit output below a specified benchmark level unrelated to the project baseline. For example, emissions may also be required to be below the average per unit output in the sector to be considered additional where a project-by-project approach to setting the baseline is used. Similarly, forestry activities may only be considered additional if GHG savings per unit of wood production, or GHG savings per unit of land area (specified independently of the project baseline) are above a particular level.

2.1.3 Project additionality

The nature of the counterfactual assumed for the baseline is fundamental to additionality determination. In cases of avoided deforestation or forest degradation, activities are generally deemed additional only where these areas would otherwise have been expected to be deforested or degraded. In some cases afforestation, reforestation and forest management activities may similarly only be deemed additional where forests are considered unable to establish themselves in the absence of the project (e.g. through natural regeneration), or woody biomass is not expected to increase in the absence of the project. To prevent carbon markets providing perverse incentives (e.g. for prior deforestation or degradation to subsequently claim credits for project activities), projects on some types of land, such as areas subject to recent anthropogenic clearance of trees, may be excluded.

2.1.4 Intent additionality

Abatement may have to be shown to have been an original objective of the project for associated GHG benefits to be considered additional. An aspect that Costa et al. (2000) term "intent" (or "program") additionality, the aim is to exclude projects for which GHG benefits are purely coincidental.

2.1.5 Tree additionality

In some cases, the number of trees planted may have to exceed the number removed by a particular margin. For example, a 'no net loss' criteria may be applied in order for GHG benefits to be considered additional.

2.1.6 Ecological additionality

To be considered additional, in some cases projects have to show positive net ecological impacts (e.g. enhance habitats, flora and fauna, and biodiversity), use 'native' species, increase resilience to climate change, or provide evidence that no genetically modified species are used. These elements could potentially be subdivided into associated sub-categories (e.g. 'habitat additionality', 'flora additionality' 'fauna additionality', 'biodiversity additionality', 'native additionality', 'resilience additionality', 'naturalness additionality', etc). Projects may have to adopt practices considered ecologically beneficial (e.g. natural regeneration) and avoid those considered harmful (e.g. broadcast fertilisation). They may also have to pass an environmental impact assessment.

2.2 Legal, regulatory and institutional additionality

Different forms of legal, regulatory and institutional additionality are apparent at the level of the individual enterprise, government and carbon certificate purchaser. At least 12 forms can be distinguished.

2.2.1 Compliance additionality

At the level of individual enterprises, only GHG benefits that exceed those associated with meeting statutory minimum standards are generally considered additional, with the chosen baseline in part based upon regulatory requirements. This form is sometimes termed ‘regulatory additionality’ (e.g. Reynolds, 2008). However, for clarity different terminology is adopted here as other elements of additionality are also associated with regulations.

2.2.2 Incentive additionality

Changes may not be mandatory, but GHG savings may nonetheless be expected to accrue as a consequence of incentives provided by existing regulatory frameworks (e.g. woodland grant schemes) or GHG-related environmental credit (e.g. renewable energy certificate) schemes. Only benefits exceeding those expected under these incentive structures may be considered additional. To prevent over-reliance on public funding, projects may also be required to have a minimum proportion of private or voluntary sector finance to be considered additional (an aspect closely related to financial additionality – see 2.3.1 below).

2.2.3 Threshold additionality

In some cases a limit may be applied to the GHG savings considered additional. The cap may depend upon the type of project and be specified in terms of maximum production, aggregate abatement or abatement per unit of production. It may be introduced to limit the size of projects due to wider environmental (or other) considerations.

2.2.4 Norm additionality

A project may have to comply with wider voluntary industry standards, codes or good practice benchmarks for GHG benefits to be considered additional. These may cover a range of socioeconomic (e.g. employment, income generation and poverty alleviation) and community engagement issues. They can also relate more broadly to sustainable forest management issues, such as watershed and soil erosion protection. For example, carbon savings from woodland creation in the UK may be considered additional only where a project conforms with various good practice guidelines under the UK Forestry Standard (Forestry Commission, 2011a).

This form of additionality could potentially also be further subdivided into sub-categories covering particular types of norms (e.g. ‘employment additionality’, ‘income additionality’ ‘poverty additionality’, ‘engagement additionality’, ‘watershed additionality’, ‘erosion additionality’, etc).

2.2.5 Technological additionality

To promote production efficiency, GHG savings may only be considered additional if they result from the application of a specific type or category of technology that differs from "business as usual" (and thus from that generally assumed under the baseline). To the extent that it involves lower monitoring costs, technological additionality may be viewed as a useful proxy for unit additionality in some cases.

2.2.6 Barrier additionality

A variety of legal, social, technological, ecological or financial barriers may exist that normally prevent particular climate mitigation activities being undertaken. For example, these may relate to weakness of existing land tenure or property rights, to soil degradation, or unfavourable climatic conditions. Projects may only be considered additional if they can be shown to overcome existing barriers.

2.2.7 Practice additionality

In some cases, only activities which are not common practice in the area in which they are located may be considered additional. For example, a woodland creation project may only be considered additional if similar projects without carbon funding are not already undertaken in a similar geographical and regulatory environment.

2.2.8 Reporting additionality

Principles applied to GHG accounting and national reporting of emissions reductions at government level may affect which project level savings are considered additional. For example, additionality is not an issue in relation to afforestation, reafforestation and deforestation activities under Article 3.3 of the Kyoto Protocol, but it can be with respect to forest management measures under Article 3.4, and is a requirement in trades between countries under Article 6 (IPCC, 2000, 5.7, Tables 5–10).

2.2.9 Institutional additionality

From the perspective of a private or voluntary sector prospective buyer, GHG benefits may only be considered additional where activities are entirely independent of, rather than part of, meeting national targets, or where they exceed those envisaged under these targets. Carbon credits that are used to meet government targets (e.g. included in national GHG inventories reported under the Kyoto Protocol), or included under binding cap-and trade schemes, and sold in voluntary carbon markets give rise to potential double-counting. In the absence of mechanisms to retire carbon certificates sold on voluntary markets, lack of this form of additionality applies to many climate change mitigation activities within countries such as the UK that have legally binding emissions reduction commitments under the Kyoto Protocol (Kollmuss, 2007). It can also exert a significant influence on voluntary carbon markets. The precipitous drop in voluntary carbon certificates sold in the EU from 2.3 mt$CO_2$e in 2007 to 0.2 mt$CO_2$e in 2008, for instance, is reported to have been due in part to double-counting concerns related to the associated reductions also being covered by national reporting under the Kyoto Protocol (Hamilton et al., 2009).

### 2.2.10 Date additionality

GHG benefits may only be considered additional and credited if they occur after a specified date, or if they are associated with specific activities or projects that commenced after (or, in a few cases, before) a particular date. To the extent that projects commencing prior to a particular date are initiated for reasons entirely unrelated to climate change mitigation, for example, only accounting for abatement from projects initiated subsequently may be viewed as important to help underpin intent additionality.

### 2.2.11 Term additionality

Related partly to practical project implementation issues such as time horizons for monitoring and verification, and level of commitment to land use change required of landowners, in some cases GHG benefits may be considered additional only if they occur within a particular time-frame. For example, abatement may be counted only if coming from a project with a time horizon above a specified minimum duration.

To ensure additionality criteria are periodically re-assessed, the maximum period that GHG benefits are considered additional may also be capped.

### 2.2.12 Jurisdiction additionality

Although often more associated with defining coverage than additionality per se, only if GHG benefits arise within a particular geographical area (e.g. specific countries), or in some cases, if activities involve particular communities or social groups, are GHG benefits considered additional.

## 2.3 Financial and investment additionality

Financial and investment aspects of additionality are closely related. In some cases, they are viewed as the key determinants of additionality and merged into a single test. Merger (2008, p. 19) takes this approach, for example, stating that “a project must provide evidence that without the additional financial means from the sale of $CO_2$ certificates the project cannot be implemented.” However, at least five aspects can be distinguished.

2.3.1 Financial additionality

Evidence often has to be provided that a project would not have been financed without revenues from the sale of carbon certificates for GHG benefits to be considered additional. Activities that would have been financed anyway (e.g. with international development assistance) are not considered additional (cf. Au Yong, 2009).

To the extent that availability of finance is a potential barrier to project implementation, financial additionality can be considered a type of barrier additionality. Financial additionality in this sense is quite different from meanings currently in international climate negotiations which focus on aggregate levels of finance (see: Bode and Michaelowa, 2003, p.507; Brown et al., 2011).

2.3.2 Viability additionality

To be considered additional, in some instances developers have to demonstrate that a project would not be economically viable without revenues from the sale of carbon certificates. In cases where projects are only financed if expected to be economically viable, this form of additionality is a prerequisite for financial additionality. It can also be considered a form of barrier additionality.

2.3.3 Investment additionality

A project may have to demonstrate that it would not be the most financially attractive option without revenues from the sale of carbon certificates in order for GHG benefits to be considered additional. This does not necessarily imply either that a project would not be financially viable without revenues from the sale of carbon certificates (viability additionality), or that it would not have been financed (financial additionality).

2.3.4 Sales additionality

Where a project commences before the date of registration under a particular standard or mechanism, often it may only be considered additional if the income from the sale of carbon credits was a decisive factor in the original decision to proceed. In many instances both investment additionality and financial additionality could be expected to be prerequisites for sales additionality. (An exception could arise if income from the sale of carbon certificates is a decisive factor despite a project not being expected to be economically viable.)

Closely related to intent additionality (which is generally a prerequisite), the purpose of sales additionality is similar in aiming to exclude projects for which carbon revenues are purely coincidental.

### 2.3.5 Gaming additionality

Some GHG emissions may be generated by activities primarily in order to obtain carbon credits for subsequent abatement (see subsequent section on perverse incentives). Where this occurs, abatement is not generally considered additional.

## 3 Tests applied to forestry projects

This section provides a review of the coverage of existing additionality protocols, focusing upon the aspects covered by tests applied to forestry projects or credits, and comparing approaches used and associated evidence requirements. Tests applied under the Kyoto Protocol Clean Development Mechanism (CDM), Air Resources Board (ARB) protocols applying to the California cap-and-trade scheme, and six voluntary market standards, including the recently launched Woodland Carbon Code (Forestry Commission, 2011b) are focused upon. Those voluntary market standards (including Greenhouse Friendly, VER+, and the Voluntary Offset Standard) currently based entirely, or almost entirely, upon CDM or other UNFCCC methodologies are excluded from separate consideration to avoid repetition. Similarly, as those used under the Kyoto Protocol Joint Implementation can follow the same methodologies used for CDM projects (see http://www.jirulebook.org/5091), these are also excluded from separate consideration below.

This expands comparisons in Valatin (2012) to include ARB, and serves to further illustrate the developmental stage of carbon market standards. Summary information for each of the standards examined is given in Table 1. This includes information on the version of each of the voluntary carbon market standards focused upon, and whether carbon certificates are issued ex-post (i.e. after), or ex-ante (i.e. before) monitoring and verification. (Note that even where carbon certificates are issued ex-post, arrangements also often allow them to be secured by advance payment prior to their issue – a practice termed ‘forward crediting’). Web links for material drawn upon for comparisons – including for the tables that follow – are listed in the notes under Table 1.

Table 1: Carbon standards and associated certificate and project types

| Mechanism or standard | Type of certificate | Timing of certificate issue | Name of unit(s) | Type of projects |
|---|---|---|---|---|
| American Carbon Registry Forest Carbon Project Standard (v2.1 Nov 2010) | Voluntary | Ex-post | Emission Reduction Ton (ERT) | A/R, IFM, REDD |
| California Air Resources Board (Oct 2011) | Compliance | Ex-post | ARB offset credit | R, IFM, AC, UF |
| Clean Development Mechanism | Compliance | Ex-post | Temporary Certified Emission Reduction (tCER); Long-term Certified Emission Reduction (lCER) | A/R |
| CarbonFix (v3.2 Dec 2011) | Voluntary | Ex-ante and ex-post | $CO_2$-certificate | A/R |
| Green-e (v2.0 June 2011) | Unrestricted | Ex-post | Unrestricted | F+ |
| Plan Vivo (Oct 2008) | Voluntary | Ex-ante | Plan Vivo Certificate | D |
| Verified Carbon Standard (v3.1 July 2011) | Voluntary | Ex-post | Verified Credit Unit (VCU) | ARR, APD, AUFDD, IFM, REDD |
| Woodland Carbon Code (v1.3 July 2011/March 2012 additionality protocol) | UK (non-tradable internationally) | Ex-post | Unrestricted | A |

Project types: A = Afforestation; R = Reforestation; A/R = Afforestation and Reforestation; ARR = Afforestation, Reforestation and Revegetation; AC=Avoided Conversion; APD = Avoiding Planned Deforestation; AUFDD = Avoiding Unplanned Frontier Deforestation and Degradation; REDD = Reduced Emissions from Deforestation and Degradation; D = Developing country community forestry; IFM = Improved Forest Management; UF= Urban Forestry; F+ = Forestry and other project types;

See the following websites: http://americancarbonregistry.org/, http://www.arb.ca.gov/cc/capandtrade/offsets/offsets.htm, http://cdm.unfccc.int/, http://www.carbonfix.info/CarbonFix-Standard.html, http://www.green-e.org/, http://www.planvivo.org, http://www.v-c-s.org, http://www.forestry.gov.uk/carboncode.

Based upon reviewing published information on their websites, types of additionality tests applied explicitly as part of additionality protocols are summarised in Table 2. Tests applying to small- and large-scale projects are distinguished in the case of CDM forestry as separate protocols apply. Note, however, that the snapshot provided may be an incomplete guide to existing practice to the extent that this also depends upon informal norms and conventions (for example, if developers of small-scale CDM forestry projects also apply tests required for large-scale projects, or included under non-binding best practice guidance).

Table 2: Explicit additionality tests applied to forestry projects

| Category | Additionality test | American Carbon Registry Forest Carbon Project Standard | California Air Resources Board | Clean Development Mechanism: | | CarbonFix | Green-e | Plan Vivo | Verified Carbon Standard | Woodland Carbon Code |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Small-scale | Large-scale | | | | | |
| Environmental | GHG | ~ | √ | √ | | ~ | | | | |
| | Unit | ~ | | | | | ~ | | ~ | |
| | Project | √ | ~ | | | √ | | | ~ | |
| | Intent | ~ | | ~ | ~ | | ~ | | | |
| | Tree | | ~ | | | | | | | |
| | Ecological | | | | | | | | | |
| Legal, regulatory and institutional | Compliance | √ | √ | | √ | ~ | √ | √ | √ | √ |
| | Incentive | | | | | | | | | √ |
| | Norm | | | | | √ | ~ | | | |
| | Technological | | | | | | ~ | | ~ | |
| | Barrier | ~ | | ~ | ~ | ~ | ~ | √ | ~ | √ |
| | Practice | ~ | | | ~ | | | | ~ | |
| | Institutional | | | | | | | | | |
| | Date | √ | ~ | | √ | ~ | √ | | | |
| | Term | | | | | | | | | |
| | Jurisdiction | | | | | | | | | |
| Financial & investment | Financial | ~ | | | | | | | ~ | ~ |
| | Viability | ~ | | | √ | ~ | ~ | | | √ |
| | Investment | | ~ | | √ | ~ | ~ | | | |
| | Sales | ~ | | | ~ | ~ | ~ | | | |
| | Gaming | | | | | | | | | |

Note: √ denotes test applied in all cases; ~ denotes applies in some cases.

Focusing upon explicit tests is informative in identifying and comparing aspects covered by additionality protocols under different standards. This only provides a partial picture, however, as similar (‘implicit’ additionality) tests exist in some cases under general eligibility requirements or other sections of the standards rather than as part of an additionality protocol. Furthermore, some protocols note that certain types of projects are assumed to pass a particular additionality test (e.g. whether it is a common practice, or not). For the purposes of wider comparisons of the scope of different standards, this is termed 'presumed additionality' and is also included in the more comprehensive comparison of additionality tests provided in Table 3. This shows, for example, that GHG additionality (quantifying net GHG benefits compared to a baseline) underpins all the standards, although it is only focused upon explicitly in demonstrating additionality in all cases under the California Air Resources Board and for small-scale CDM projects.

Table 3: Explicit and implicit additionality tests applied to forestry projects

| Category | Additionality test | American Carbon Registry Forest Carbon Project Standard | California Air Resources Board | Clean Development Mechanism: | | CarbonFix | Green-e | Plan Vivo | Verified Carbon Standard | Woodland Carbon Code |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Small-scale | Large-scale | | | | | |
| Environmental | GHG | ~‡ | √ | √ | ¶ | ~‡ | ¶ | ¶ | ¶ | ¶ |
| | Unit | ~ | | | † | † | ~ | | ~ | |
| | Project | √ | ~¶ | ¶ | ¶ | √¶ | | | ~ | |
| | Intent | ~ | | ~ | ~ | | ~ | | † | |
| | Tree | | ~ | | | | | | | |
| | Ecological | ¶ | †¶ | | | ¶ | ¶ | ¶ | ¶ | ¶ |
| Legal, regulatory and institutional | Compliance | √ | √ρ | | √ | ~ | √ | √ | √ | √ |
| | Incentive | | | | | | | | ¶ | √ |
| | Norm | ¶ | | ¶ | ¶ | √¶ | ~ | ¶ | ¶ | ¶ |
| | Technological | | | | | | ~ | | ~ | |
| | Barrier | ~ | | ~ | ~ | ~ | ~ | √ | ~ | √ |
| | Practice | ~ | ρ | | ~ | | | | ~ | |
| | Institutional | | | | | | ¶ | | ¶ | |
| | Date | √ | ~ | ¶ | √ | ~ | √ | ¶ | | ¶ |
| | Term | ¶ | ¶ | ¶ | ¶ | ¶ | ¶ | ¶ | ¶ | ¶ |
| | Jurisdiction | | ¶ | ¶ | ¶ | | | ¶ | | ¶ |
| Financial & investment | Financial | ~ | | | | | | | ~ | ~ |
| | Viability | ~ | | | √ | ~ | ~ | | | √ |
| | Investment | | ~ | | √ | ~ | ~ | | | |
| | Sales | ~ | | | ~ | ~ | ~ | | † | |
| | Gaming | | | | | | | | ¶ | |

Notes: Explicit additionality test: √ applied in all cases; ~ applied in some cases. Implicit additionality test: ¶ applied in all cases; ‡ applied in cases an explicit test does not apply; † applied in some cases. Presumed additionality test applied in some cases: ρ. In some cases more than one test apply.

Marked differences in the range of additionality tests exist between standards (Tables 2 and 3). However, these appear largely unrelated to whether ex-post and ex-ante certificates are issued (Table 1). Furthermore, there is flexibility under some standards for the project developer to choose how to demonstrate additionality, with specific combinations of the tests treated as alternatives in some cases.

Similarities and differences in the specific types of additionality tests applied are considered next.

## 3.1 Environmental additionality tests

### 3.1.1 GHG additionality tests

The GHG additionality test specified under the CDM for small-scale Afforestation and Reforestation (A/R) projects involves demonstrating that within the project boundary the net GHG removals by sinks are increased above the sum of changes in carbon stocks in the carbon pools that would otherwise have occurred. Where used as part of the additionality protocol, the test under CarbonFix is similar, being based upon the latest CDM additionality tool. If project proponents provide relevant evidence indicating that no significant changes in the carbon stocks within the project boundary would occur in the absence of the project, existing carbon stocks prior to implementation of the project are considered as the baseline (and assumed constant throughout the crediting period). If significant changes in carbon stocks within the project boundary are expected in the absence of the project, an approved simplified baseline and monitoring methodology for small-scale A/R projects must be used. The carbon pools covered under these vary between different project categories and types of location as illustrated in Table 4.

Table 4: Coverage of small-scale CDM A/R baseline methodologies

| Project location (prior land use)/type | CDM reference | Carbon pools | | | | | |
|---|---|---|---|---|---|---|---|
| | | Above-ground tree biomass | Above-ground woody perennials biomass | Below-ground grassland biomass | Below-ground tree biomass | Below-ground woody perennials biomass | Soil organic carbon |
| Grasslands or Croplands | AR-AMS0001 † | √ | √ | √ | √ | √ | |
| Settlements | AR-AMS0002 ‡ | √ | | | √ | | |
| Wetlands | AR-AMS0003 ¶ | √ | | | √ | | |
| Agroforestry | AR-AMS0004 ζ | √ | | | √ | | √ |
| Low Quality lands | AR-AMS0005 ξ | √ | | | √ | | √ |
| Silvopasture | AR-AMS0006 Ψ | √ | | | √ | | √ |

Notes: † version 05 (EB 42); ‡ version 02 (EB 42); ¶ version 01; ζ version 02 (EB 47); ξ 02 (EB 46); Ψ 01 (EB 47).

Source: http://cdm.unfccc.int/methodologies/SSCmethodologies/SSCAR/approved.html

Although not explicit additionality tests (except where the small-scale forestry CDM protocol is adopted under CarbonFix), it is notable that carbon pools covered in setting project baselines under the voluntary carbon standards also differ. This is illustrated in Table 5, in which, the two standards which do not specify carbon pools covered explicitly, are excluded. (Under Green-e validation, monitoring and verification standards must be "explicit, transparent and credible"; while under Plan Vivo carbon accounting has to be based upon "best available evidence"). The approach under the Woodland Carbon Code differs from most other standards in using standardised baselines (based upon 'carbon look-up tables'), rather than project-specific baselines.

Table 5: Carbon pools and other GHGs covered under voluntary carbon standards

| | | American Carbon Registry Forest Carbon Project Standard | California Air Resources Board | | | | Carbon Fix | Verified Carbon Standard | | | | | | Woodland Carbon Code |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Reforestation | Improved Forest Management | Avoided Conversion | Urban Forestry | | Afforestation, Reforestation and Revegetation | Conversion to reduced impact logging (RIL) with minimal impact on timber | Conversion to RIL with over 25% reduction in timber extracted, or from logged to protected forests | Extended rotation length / Conversion of low productive forests to productive forests | Conversion of forest to non-forest annual crop or pasture | Conversion of forest to perennial tree crop (e.g. oil palm, bananas, fruit trees, spice trees, tea shrubs) | |
| Above Ground Biomass | Tree | | √ | √ | √ | | | √ | √ | √ | √ | √ | √ | √ |
| | Non-tree | | √ | | | | | Δ | | | | | √ | √ |
| | Woody | | | | | | √ | | | | | | | |
| | Non-woody | | | | | | √ | | | | | | | |
| Deadwood | Standing | | √ | √ | √ | | | | √ | √ | | | | |
| | All | | | | | | | | | | | | | √ |
| Below Ground Biomass | Tree | | | | | | | | | | | | | √ |
| | Non-tree | | | | | | | | | | | | | √ |
| | Woody | | | | | | √ | | | | | | | |
| | Non-woody | | | | | | √ | | | | | | | |
| | All | | | | | | | Δ | ~ | ~ | ~ | ~ | ~ | |
| Tree biomass | | | | | | √ | | | | | | | | |
| Litter | | | | | | | | Δ | ~ | ~ | ~ | ~ | ~ | √ |
| Soil | | | ~ | ~ | ~ | | | Δ | ~ | ~ | ~ | Δ | Δ | √ |
| Site preparation | Biological emissions | | √ | √ | | | | | | | | | | |
| | Fuel emissions | | √ | | | | | | | | | | | |
| Tree planting/care | Fuel emissions | | | | | √ | | | | | | | | |
| Woodland management | | | | | | | | | | | | | | √ |
| Clearing forest land outside project area | Biological emissions | | √ | | √ | | | | | | | | | |
| Changes in wood harvesting outside project area | Biological emissions | | | ~ | | | | | | | | | | |
| Harvested Wood products | In-use | | √ | √ | √ | | | | | | | | | |
| | In landfills | | ~ | ~ | ~ | | | | | | | | | |
| | Decomposition | | √ | √ | √ | | | | | | | | | |
| | All | | | | | | | ~ | ~ | √ | ~ | ~ | ~ | |
| Unspecified / other | | (1) | | | | | (2) | | | | | | | |

Notes: √ denotes covered in all cases; Δ denotes has to be included where project activities may significantly reduce pool; ~ denotes covered in some cases; (1) All significant changes in carbon pools/GHG sources with exception of litter, and emissions from removal of herbaceous vegetation, fertiliser application, and of nitrous oxide ($N_2O$) from litter and fine root decomposition; (2) 0.5% of future $CO_2$ fixation deducted to cover within project fossil fuel use (e.g. by machines and flights). Where fertiliser is used, 0.005 $tCO_2$ per kg of nitrogen is deducted. Any biomass burned in land preparation is assumed to add 10% to baseline emissions to cover $N_2O$ and $CH_4$ emissions.

Coverage of carbon pools and other GHG fluxes also varies between project types for large-scale forestry CDM projects (see: Valatin, 2011, Table 6, p.21).

Framing of the GHG additionality test under the ARB is similar to that for large-scale forestry CDM projects in terms of the focus upon GHG reductions or removal enhancements in excess of those expected under business-as-usual activities. However, in practice no GHGs apart from $CO_2$ are covered under the protocol for US forest projects (see: ARB, 2011a, section 5) at present. In principle they are covered where 'significant' under the protocol for urban forest projects, but as no guidance on how they are to be estimated is provided (see: ARB, 2011b, sections 4 and 5), in practice this protocol focuses upon carbon fluxes.

### 3.1.2 Unit additionality tests

Indicators used differ between the standards. Under Green-e it has to be shown that GHG emissions are reduced below levels of technologies commonly used to produce the same products/services. The Verified Carbon Standard (VCS) test involves demonstrating that carbon sequestration per unit of output by the project is above (or GHG emissions generated below) the benchmark level approved for the product, service, sector or industry. (Although a similar approach to Green-e is also specified, this appears less relevant to woodland projects). The test under the American Carbon Registry Forest Carbon Project Standard (ACRFCPS) focuses on demonstrating that an activity exceeds a performance standard benchmark representing typical forest management of the forest type and region in which the project takes place. The benchmark in this case may be based upon net sequestration and emissions rates, or upon emissions per unit of output (e.g. of harvested wood products) along similar lines to standards applying in other sectors.

Labels used differ. Tests under the ACRFCPS and the VCS are termed a 'performance benchmark', while that under Green-e (in contrast to terminology adopted in this article) is termed a 'common practice' test.

3.1.3 Project additionality tests

A land eligibility test applying to (A/R) projects is included under the ACRFCPS which requires that none of the land was subject to anthropogenic clearing of native ecosystems within 10 years of the project start date. Where loss of cover occurred due to natural disturbance, it has to be demonstrated that there is no natural recovery. The test under CarbonFix similarly applies to woodland creation, with evidence required that there would be no increase in woody biomass on the area to be planted in the absence of the project (and where this does not hold, any increase has to be accounted for in establishing the baseline).

Under the ARB, official documentation has to be provided for avoided conversion projects demonstrating that the anticipated land use conversion is legally permissible and evidence provided that the project area is suitable for conversion. Where conversion to commercial, residential or agricultural land is anticipated, the project area must have a slope of not more than 40 percent. Where conversion to agricultural land is anticipated, evidence has to be provided that the soil is suitable and water available for the expected agricultural land use, while where conversion to mining is anticipated, evidence has to be provided of the extent and amount of mineral resources within the project area.

General requirements of additionality demonstration and baseline determination under VCS mention deforestation and degradation rates among factors that can require assessment across a given geographical area.

3.1.4 Intent additionality tests

The form of intent additionality tests used for projects commencing prior to registration is similar under different standards. A project starting before November 1997 may be approved under the ACRFCPS if documentation is provided to show that GHG mitigation was an objective from the inception of the project (and approved methodologies can also require documentation to demonstrate that GHG mitigation was originally a primary objective). Similarly, credits from a project starting prior to 2000 may be deemed additional under Green-e if it is demonstrated that they are for activities initiated in part for the purpose of reducing or displacing GHG emissions.

Under the CDM, those projects commencing before 2 August 2008 and prior to publication of a project design document have to demonstrate that the CDM was seriously considered at the outset. Evidence has to be shown that CDM benefits were a decisive factor, and that continuing actions were made in parallel with implementation to secure CDM status, with these commencing no more than 3 years after the start of the project. For projects starting subsequently, within the first 6 months developers have to inform a designated national authority in the host country and the UNFCCC secretariat of their intention to seek CDM status.

### 3.1.5 Tree additionality tests

Under the ARB, urban forest projects undertaken by municipalities and on educational campuses must include planting at least as many trees as are removed, and exceed the business-as-usual net tree gain (the annual number of trees planted minus the annual number removed). This can be estimated for a single year, or series of years, over the previous 5 years, and the 5-year moving average annual net tree gain reported on an ongoing basis, with no carbon benefits associated with trees planted in any year in which the net tree gain is negative considered additional.

## 3.2 Legal, regulatory and institutional additionality tests

### 3.2.1 Compliance additionality tests

The structure of most of the regulatory compliance tests is fairly uniform across different standards. However, there are differences in the breadth of coverage and evidence requirements.

The test specified under Plan Vivo is relatively narrow in only considering compliance with legal requirements. Tests under the CDM for large-scale projects, the VCS and (where used) the CarbonFix standard, are slightly broader in considering both legal and regulatory requirements.

By comparison, tests under the ACRFCPS, the ARB, Green-e, and under the Woodland Carbon Code are broader still. The ARB protocol for U.S. forest projects takes into consideration federal, state and local laws, regulation and ordinance, as well as legally binding mandates including forest management plans, conservation easements and deed restrictions (except where enacted in support of the project). The Green-e standard considers compliance with public policy, regulations, legal mandate and guidance, including those not specifically related to GHG emissions. The ACRFCPS takes account of existing laws, regulations, statutes, legal rulings, and regulatory frameworks directly or indirectly affecting GHG emissions from a project or its baseline, including mandatory forest management/forest practice rules. Similarly, the Woodland Carbon Code considers laws, statutes, regulations, court orders, environmental management agreements, planning decisions and other legally binding agreements requiring woodland creation, or implementation of measures that would achieve equivalent levels of sequestration or other GHG reductions. This excludes compensatory planting required to replace areas of woodland that are felled for purposes such as development, or restoration of open habitats, for example.

Exclusions apply in some cases. Under the VCS recent legal requirements, regulatory frameworks and policies that provide comparative advantages to some technologies do not need to be taken into account in some cases.

### 3.2.2 Incentive additionality tests

Projects that receive grant aid from a government funded initiative for woodland planting, establishment or management are only eligible under the Woodland Carbon Code if a minimum proportion of funding is from other sources. At present (as of April 2012) other sources of finance have to provide at least 15% of the total planting, establishment and forest management costs over the life-time of the project, with woodland grant payments covering at most 85% of the costs, but these limits are likely to change in future.

### 3.2.3 Norm additionality tests

The breadth of tests applied varies under different standards. Under Green-e, compliance with industry standards generally, including those not specifically related to GHG emissions, has to be demonstrated. (This forms part of a combined legal/regulatory/institutional test.) Under CarbonFix evidence has to be provided that a project contributes more to sustainable development in the short-, medium- and long-term than the most likely without-project scenario. Types of evidence required are unspecified.

### 3.2.4 Technological additionality tests

A similar core element is used under the different standards. The test under Green-e involves showing that the technology used is near the top of the standard's list of technologies on net GHG emission rates for similar technologies and practices producing similar products or services. The test under the VCS involves showing that a project uses less emissions-intensive technology than a business-as-usual option, and that it meets specific technology and performance criteria. It must also result in a minimum level of GHG savings (e.g. related to market penetration). Although a technology test could be applied to elements of woodland projects such as GHG emissions associated with machinery and chemical use in planting, establishment or forest management activities, associated documentation makes no mention of its applicability to such activities. It is therefore unclear to what extent the test is used at present for woodland projects or is confined to GHG emissions reduction projects in other sectors.

### 3.2.5 Barrier additionality tests

The breadth of barriers considered in distinguishing projects that would otherwise not be implemented differs between standards. Explicit coverage of different types of barrier is summarised in Table 6.

Table 6: Coverage of barrier tests under different standards

| **Types of barriers** | **American Carbon Registry Forest Carbon Project Standard** | **Clean Development Mechanism** | | **Green-e** | **Plan Vivo** | **Verified Carbon Standard (VCS)** | **Woodland Carbon Code** |
|---|---|---|---|---|---|---|---|
| | | **Small-scale** | **Large-scale** | | | | |
| Capacity | | | | √ | | | |
| Cultural | | | | √ | √ | | |
| Ecological/environmental | | √ | √ | | | | √ |
| Financial | √ | | √ | | √ | √ | √ |
| Investment | √ | √ | | | | √ | |
| Infrastructure | | | | √ | | | |
| Institutional | √ | √ | √ | √ | | √ | |
| Legal | | | | | | | |
| Local | | | | √ | | | |
| Organisational | | | | √ | | | |
| Prevailing practice | | √ | √ | | | | |
| Property rights | | | √ | | | | |
| Social | | √ | √ | | √ | | √ |
| Supply | | | | √ | | | |
| Technological | √ | √ | √ | | √ | √ | √ |
| Tradition | | √ | √ | | √ | | |

Although some overlap in classifications of different types exists between standards, on the whole, voluntary market standards explicitly account for a narrower range of potential barriers than the tests under the CDM. A notable exception is the lack of requirement under the test for small-scale CDM forestry projects (where used) to consider economic/financial barriers. The latter, which in some cases encompass financial and investment additionality criteria (see below), are explicitly covered under barrier tests under the ACRFCPS, Plan Vivo, VCS and the Woodland Carbon Code (as well as the test applying to large-scale CDM forestry projects). The focus of the test under Plan Vivo is broader than those under the other standards in taking account of barriers in the absence of broader project development (in addition to those in the absence of carbon finance).

The evidence required is specified explicitly only in the case of large-scale CDM forestry projects and can be of a variety of kinds. This may include legislation, environmental resource management norms or rules, statistical or market data, sectoral studies, minutes from Board meetings, correspondence, feasibility studies, financial or budgetary information, and documents written by independent experts.

3.2.6 Practice additionality tests

The test for large-scale A/R projects under the CDM (and CarbonFix in cases where a test is applied) initially focuses on whether similar activity not registered under the CDM already occurs within the geographical area of the proposed project. If so, developers have to demonstrate essential distinctions for a project to be considered additional. These may include a fundamental and verifiable change in circumstances since similar activities were implemented (e.g. due to the end of promotional policies, or the existence of barriers). Similar activities are defined as those of similar scale, taking place in the relevant geographical area and a similar environment – including with respect to the regulatory framework (UNFCCC, 2007). Tests under the VCS are also similar in requiring that the project type without carbon finance is not common practice in the sector/region, or where it is, identifying barriers faced compared with existing projects.

By contrast, the ACRFCPS test appears more nuanced. It involves demonstrating that the project activity exceeds the common practice of similar landowners managing similar forests in the region (e.g. by comparing forest management plans). This allows for potential differences in forest management approaches between different types of landowner.

3.2.7 Date additionality tests

Tests under the CDM and the Green-e standard employ the same cut-off date of 1 January 2000 (as does CarbonFix in cases where a test is applied). Under the ACRFCPS a forestry project must have started after 1 November 1997. Under the ARB urban forest protocol, projects have to commence after December 31 2006 unless otherwise stipulated in the applicable Compliance Offset Protocol approved by the Board, or an early action offset project.

There is flexibility in some cases under ACRFCPS and Green-e, however, as projects commencing before these dates may be approved if an intent additionality test is passed, or (under Green-e) if a sales additionality test is passed.

### 3.3 Investment and financial additionality tests

Viability and investment additionality test elements under some voluntary carbon standards are essentially indivisible. Under Plan Vivo, for example, it has to be shown that the project or activity could not have happened in the absence of carbon finance, with no particular methodology specified. Similarly, the test under the VCS (specified as a potential element of an investment barrier assessment) considers whether investment return constraints exist that can be overcome by carbon revenues.

#### 3.3.1 Viability additionality tests

Tests under Green-e and ACRFCPS focus upon showing that the project would produce an unacceptably low rate of return in the absence of carbon funding. Similarly, the test used under the Woodland Carbon Code requires evidence that the project would not have been viable and therefore would not have gone ahead without carbon finance, taking account of grants available for UK woodland creation. Evidence such as net present value and internal rate of return calculations is required under the ACRFCPS, and under the Woodland Carbon Code, with a full financial analysis of expected costs and revenues over the lifetime of the project required under the latter.

The protocol for large-scale forestry projects under the CDM is more involved than those under other standards (apart from CarbonFix where the same test is used). It involves determining whether in the absence of carbon finance through the CDM the project would be less economically or financially attractive than continuation of the existing land use. A simple cost analysis test is applied to projects in cases with no financial benefits apart from CDM-related income. This involves documenting incomes and costs associated with the project and comparing these with those associated with continuation of the current land use. For projects which also generate non CDM-related income, investment comparison analysis is used to determine whether the project has a lower return based upon the financial indicator considered most suitable for the project type and context. This may be the internal rate of return on the project or on the equity, the net present value, payback period, or cost-benefit ratio. Sensitivity analysis is then used to identify whether this conclusion is robust.

#### 3.3.2 Investment additionality tests

The tests for large-scale forestry projects under the CDM compare project returns with those for other alternative land use change scenarios (as opposed to continuation of the existing land use). Apart from this different focus, the tests are the same as for viability additionality under the CDM described in the previous subsection, with one exception. As an alternative to investment comparison analysis, benchmark analysis can be used based upon one of the same indicators, or upon the required rate of return on investment or equity. The indicator excluding carbon revenues is compared with the benchmark value and, if lower, sensitivity analysis is then used to identify whether this conclusion is robust to reasonable variations in critical assumptions. The CDM approach can also be used under CarbonFix.

For avoided conversion projects under the ARB, the fair market value of the land under the anticipated alternative use has to be at least 40 percent greater than the current value under forest. Under Green-e, if credits come from a project that produces goods or services apart from GHG emissions reductions, it must be demonstrated that it is not the least-cost option to produce these.

### 3.3.3 Financial additionality tests

Tests under the ACRFCPS and the VCS are similar. Specified as an element of a financial barrier assessment, the test under the ACRFCPS focuses on demonstrating the existence of barriers such as limited access to capital in the absence of carbon revenues. Specified as a potential element of an investment barrier assessment, the test under the VCS considers whether there are capital constraints that can be overcome by carbon revenues. Where included, the test under the WCC is part of a barrier assessment, with supporting evidence (e.g. from a bank) required.

### 3.3.4 Sales additionality tests

The focus and form of tests used differs. Where used, the test under the CDM appears most demanding in terms of evidence requirements.

A project starting prior to 2000 may be deemed additional under Green-e if it is demonstrated that it was partly induced by the existence or anticipation of the voluntary carbon market. Similarly, for activities commencing before project registration, the developers of large-scale CDM projects have to provide documentary evidence that income from sale of CERs was seriously considered in the decision to proceed. It is preferred that legal, documentary or corporate evidence that had been available to third parties at, or prior to, the start of the project is provided. The CDM approach can also be used under CarbonFix.

Relating to whether carbon revenues are crucial in the decision to proceed, the test under the ACRFCPS aims to assess whether carbon market incentives are a key element in overcoming technological barriers. Similarly, one of three alternative financial tests applied under Green-e aims to determine whether emission reduction funding is essential for the project to move forward.

## 4 Perverse incentives

Perverse incentives induce negative unintended consequences stemming from the characteristics or manner in which a mechanism is introduced. As a primary focus of concern about the additionality of carbon credits, it is useful to consider evidence in relation to HFC-23 destruction projects and the relationship to underlying incentive structures.

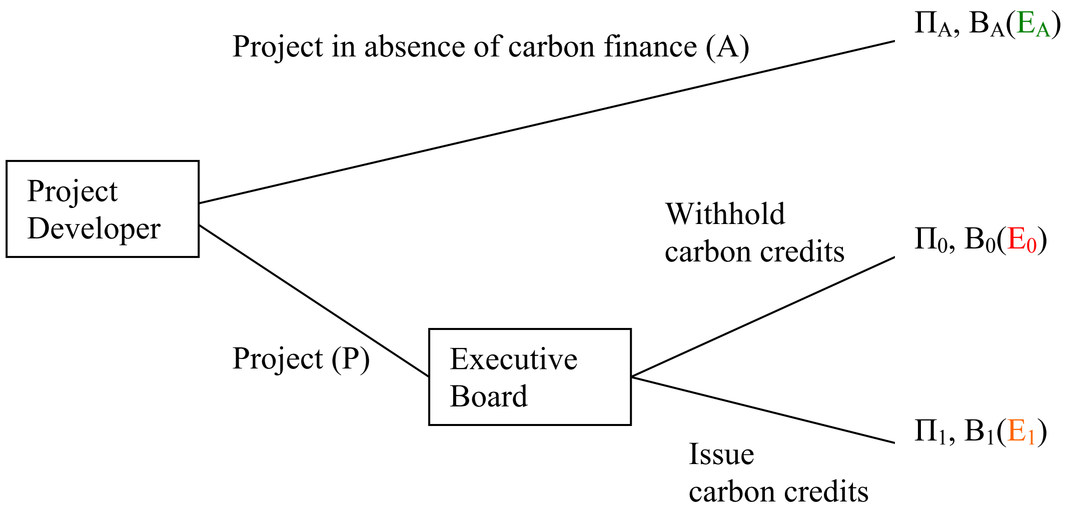
4.1 HFC-23 destruction projects

A byproduct of hydrocarbonflurocarbon-22 (HCFC-22) production, HCF-23 is a very potent GHG with a global warming potential (GWP) of 14,800 times that of carbon dioxide over a 100-year period (Forster et al., 2007, Table 2. 14). With the cost of destroying HCF-23 a fraction of the market value of associated carbon reduction credits (typical marginal abatement costs are below \$1/t$CO_2$e) and the credits worth several times the HCFC-22 produced, companies are reported to make huge profits from HCF-23 destruction projects (EIA, 2010; Scolnick, 2010). Although HCFC-22 is an ozone-depleting substance and production for use as a refrigerant or other emissive purposes (e.g. air conditioning) is regulated at international level under the Montreal protocol, production for feedstock purposes (e.g. for production of polytetrafluoroethylene) is not. As a consequence companies have been able to establish new HCFC-22 production facilities and, until recently, claim carbon credits for destroying the HCF-23 produced. HCF-23 destruction projects account for the majority of CERs issued to date. They also account for the majority of offsets purchased by companies within the European Union Emissions Trading Scheme (EIA, 2010) to date, although from 2013 their use will no longer be permitted. A comprehensive review of monitoring reports for HCF-23 projects approved under the CDM (Schneider, 2011a) found that HCFC-22 production plants produced more HCF-23 when the destruction of this GHG could be credited than in other periods, suggesting that the CDM also provides perverse incentives for existing plants to generate more HFC-23.

4.2 Underlying incentive structures

Project developers face incentives to implement projects which increase emissions if they expect to obtain revenues from the sale of carbon certificates for subsequently reducing emissions and this increases their net returns. The underlying incentive structure can be illustrated using a simplified version of the two-stage additionality game developed by Calel (2011) that is shown in Figure 1. The three potential outcomes have payoffs to the project developer ranked $\Pi_1>\Pi_A>\Pi_0$ and associated GHG emissions ranked $E_0>E_1>E_A$. In the first stage of the game the project developer has to decide whether to initiate project P, or alternative A (representing the baseline – possibly not undertaking a project at all). If P is chosen, the project may be issued with carbon credits in the second stage of the game by the CDM executive board (EB) providing the project developer adopts technology that leads to lower GHG emissions ($E_1$) than those ($E_0$) expected to arise for project P otherwise. The second stage of the game (which only occurs if P is chosen) involves the EB deciding whether to issue the project developer with carbon credits for the project. As GHG emissions are lower under project P if credits are issued than if they are withheld ($E_1<E_0$), the EB's best response is to issue credits if the project developer chooses P. Anticipating that the EB will issue credits if P and associated GHG abatement technology is adopted, the project developer undertakes the project as, with the carbon credits, it yields a higher payoff than alternative A ($\Pi_1>\Pi_A$). GHG emissions increase ($E_1>E_A$) as a consequence of project P being undertaken. Despite this increase in emissions, the outcome {undertake P, issue credits} is the unique equilibrium (sub-game perfect solution) of the one-shot game. For repeated games, the outcome also depends on other factors such as discount rates. However, repetition is argued to be unlikely to change the equilibrium, as in each game the best response of the EB to a project developer's choice of P is to issue credits (Calel, 2011). Based upon a preference for low emissions, 'payoffs' to the EB are shown in Figure 1 ranked $B(E_A)>B(E_1)>B(E_0)$.

**Figure 1: Additionality Game**



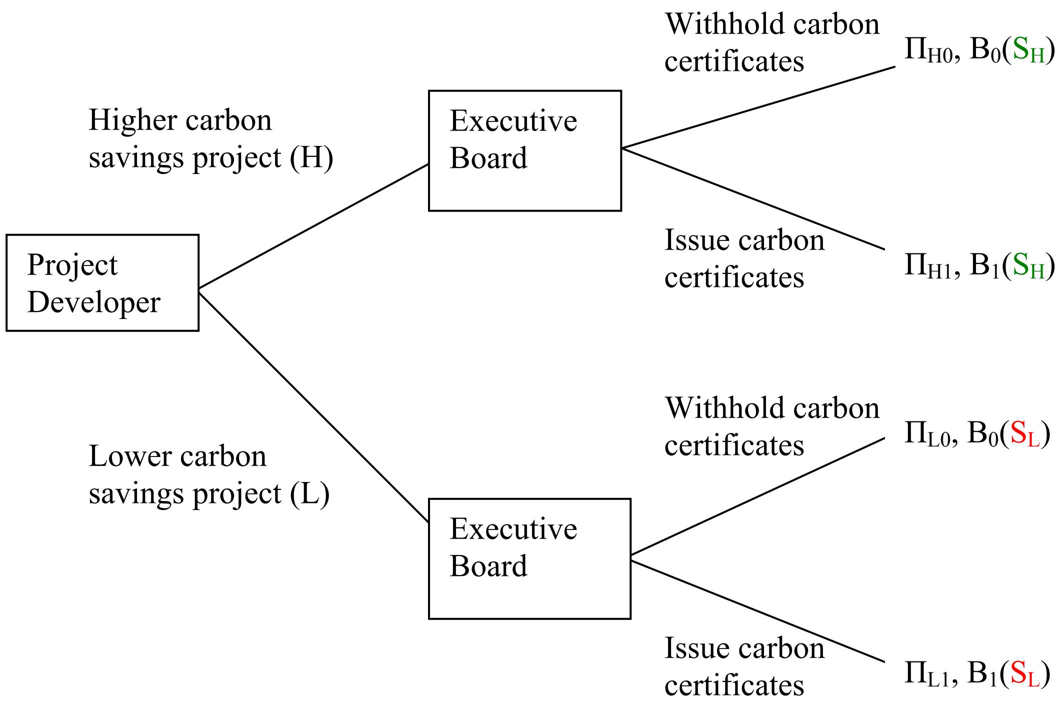

Additionality game: The Project Developer chooses at the initial node (left) project P, or alternative A. If P is chosen, the Executive Board chooses at the second node whether to issue or withhold carbon credits. Any issue of credits is contingent on the Project Developer adopting emissions reduction technology. The payoffs to the Project Developer and Executive Board based upon the associated level of emissions are given at the game's terminal nodes (right). Solving by backward induction, the Executive Board chooses to issue carbon credits rather than withholding them if the Project Developer chooses project P as this leads to reduced emissions for the project. Anticipating the Executive Board will issue credits, the Project Developer chooses project P. The subgame-perfect Nash equilibrium is given by the pair of strategies {Undertake project P, Issue credits}, with the payoff to the Project Developer and associated emissions of $\{\Pi_1, E_1\}$.

4.3 Incentive structures and forestry

Similar perverse incentives to the structure shown in Figure 1 could apply to reduced degradation and deforestation (REDD) projects if there is no project additionality test precluding land being deforested or degraded in order to claim carbon credits for subsequent reforestation or restoration. However, it is highly unlikely analogous cases could arise in countries such as the UK where the current regulatory framework includes requirements for replanting woodland after felling.

It is also difficult to envisage cases in a UK forestry context directly analogous in magnitude of effects to the situation arising from perverse incentives to produce HFC-23 in order to obtain carbon credits for its subsequent destruction. Nonetheless, a modified version of the additionality game which is applicable to UK woodland creation projects is shown in Figure 2.

**Figure 2: Woodland Additionality Game**




Woodland additionality game: The Project Developer chooses at the initial node (left) between project H with high GHG savings, or project L with low GHG savings. Once this choice has been made, the Executive Board chooses at the next node whether to issue or withhold carbon certificates depending whether the project provides additional GHG  savings compared to the baseline. The payoffs to the Project Developer and Executive Board are given at the game's terminal nodes (right). The payoff to the Executive Board is based upon the level of GHG savings it considers additional. Where the Executive Board is expected to issue carbon certificates only if project L is chosen, the Project Developer chooses project L if the payoff with the certificates is greater than from project H without certificates. Where the Executive Board is expected to issue carbon certificates for either project, the Project Developer chooses project L if the payoff with certificates is greater than from project H with certificates. In both cases the subgame-perfect Nash equilibrium is given by the pair of strategies {Undertake project L, Issue credits}, with a payoff to the Project Developer and associated GHG savings of $\{\Pi_{L1}, S_L\}$.

The 'Woodland Additionality' game posits a project developer facing the choice between two woodland creation options. GHG savings in each case are assumed independent of whether certificates are issued, with higher savings (S) associated with project H than project L ($S_H > S_L$). Two cases could plausibly lead the project developer to choose L in preference to H. In both cases the project developer anticipates that the EB views L as providing additional benefits and will issue carbon certificates if chosen, reflected in an implicit ordering of EB payoffs $B_1(S_L) > B_0(S_L)$.

First, if the project developer anticipates carbon certificates will not be issued for H (a similar case to the game in Figure 1), reflected by an ordering of EB payoffs $B_0(S_H) > B_1(S_H)$, L is preferred if the expected return including revenue from carbon certificates is higher (i.e. if $\Pi_{L1} > \Pi_{H0}$). Despite the lower GHG savings ($S_L$), choosing L is rational for the project developer as it offers higher returns. Such a situation could arise if the application of additionality criteria (e.g. an investment additionality test) precludes claiming carbon certificates for H but not project L, for example. This would be consistent with the observation (e.g. Bode and Michaelowa, 2003) that application of additionality criteria can result in incentives to invest in projects that are relatively high cost and offer relatively low GHG savings.

Second, if the project developer anticipates carbon certificates will be issued for H, reflected by an ordering of EB payoffs $B_1(S_H) > B_0(S_H)$, L is preferred if it offers a higher return taking account of the level of carbon certificates (i.e. $\Pi_{L1} > \Pi_{H1}$). Such a situation could arise where the baseline used for determining additionality and subsequent crediting is not comprehensive. If carbon displacement benefits of using timber instead of more fossil-fuel intensive materials are accounted for in estimating overall benefits, for example, but not in issuing carbon certificates, this might lead to projects being undertaken with high sequestration benefits, but relatively low overall GHG abatement benefits ($S_L$).

4.4 Potential implications of perverse incentives for UK woodland projects

The woodland additionality game helps clarify how perverse incentives could arise due either to incomplete coverage of project baselines, or associated with use of certain types of additionality tests (e.g. financial, viability, or investment additionality tests). The extent to which perverse incentives affect UK woodland carbon projects in practice is unclear, however.

Perverse incentives arise in the case of HFC23 destruction projects in part due to the high revenues from carbon credits compared to the low abatement costs (Schneider, 2011a). Involving principally carbon dioxide (which as noted above has a far lower GWP than HFC23), similar disparities between abatement costs and carbon revenues are unlikely at present for woodland carbon projects in the UK. Forestry returns in the UK have traditionally been modest (Valatin and Starling, 2010), with emerging prices for forestry carbon apparently far below social values recommended for use in public policy appraisals (DECC, 2010). Furthermore, one of the remedies suggested (issuing only a proportion of carbon certificates) is already a feature of the approach under the Woodland Carbon Code (Forestry Commission, 2011b) – albeit adopted for different (permanence risk management) reasons.

More complete coverage of project baselines could help reduce risks of perverse incentives affecting woodland carbon projects in the UK. The focus on sequestration, for example, could be expected to favour longer rotations even if shorter rotations offer higher overall GHG benefits once displacement is accounted for. (Examples of impacts on optimal rotation length of the inclusion or exclusion of carbon sequestration and displacement benefits can be found in Price and Willis (2011).) However, greater information requirements, complexities and uncertainties, as well as potential impacts on the volume of abatement undertaken if costs to project developers increase, are also relevant in considering the potential for extending coverage of the UK Woodland Carbon Code or other standards. Changes in ancillary societal benefits associated with any shift in average harvesting age could be a further important consideration to the extent that taking these into account provides a more comprehensive perspective in considering potential impacts.

In some cases perverse incentives may be reduced by using a further (e.g. gaming additionality or date additionality) test. Willis et al. (2012), for example, reports introduction of new rules under the CDM which stipulate that HCFC-22 production plants have to have operated for at least three years between 2000 and 2004 and be running in 2005 in order for abatement by HCF-23 destruction to be credited.

Even where a particular test creates perverse incentives, this does not necessarily imply it should not be used. Bloomgarden and Trexler (2008) note in relation to tests based upon a hypothetical counterfactual that some fraction of non-additional reductions will always pass, while some fraction of truly additional reductions will always fail, and the challenge is to find an acceptable balance. The situation in considering use of an additionality test associated with perverse incentives is similar, but includes a further element. The challenge is to seek an acceptable balance between the fall in non-additional reductions due to use of the test on the one hand, and the increase in GHG emissions due to perverse incentives together with the fall in truly additional abatement due to application of the test on the other.

## 5 Summary and conclusions

As demonstrated above, additionality is a multi-faceted concept. At least 6 forms of environmental additionality, 12 of legal, regulatory and institutional additionality, and 5 of financial and investment additionality, can be distinguished. These are summarised in Table 7 and cover key aspects under existing carbon standards and additionality protocols.

Table 7: Forms of additionality

| Type | Description |
|---|---|
| *Environmental:* | |
| GHG | Positive overall impact on GHG balances (net carbon benefit of activity or project). |
| Unit | Emissions per unit output below specified level (or possibly GHG savings per unit area above a threshold level). |
| Project | a) Afforestation and reforestation: forests unable to establish themselves in the absence of planned activities or project;<br>b) Avoided deforestation or forest degradation: forests would have been deforested or degraded in the absence of the project. |
| Intent | GHG abatement a decisive factor in decision to proceed. |
| Tree | Positive impact on the total number of trees. |
| Ecological | Positive net impacts on habitats, species and biodiversity. |
| *Legal, regulatory, Institutional:* | |
| Compliance | Exceeds statutory requirements. |
| Incentive | Exceeds benefits associated with incentives provided by regulatory framework. |
| Threshold | Does not exceed maximum GHG savings counted as additional. |
| Norm | Meets voluntary industry standards, or good practice benchmarks. |
| Technological | Application of specific technology. |
| Barrier | Overcomes implementation barrier. |
| Practice | Not common practice. |
| Reporting | National GHG accounting and reporting additionality rules. |
| Institutional | Independent of statutory emissions reduction targets. |
| Date | Activities occur after (or in some cases before) particular date. |
| Term | Abatement arises within a specified time-scale. |
| Jurisdiction | Activities in particular location, or undertaken by specific communities or social groups. |
| *Financial and investment:* | |
| Financial | Would not be financed without sale of carbon certificates. |
| Viability | Not financially viable without sale of carbon certificates. |
| Investment | Not most attractive option without sale of carbon certificates. |

| Type | Description |
|---|---|
| Sales | Income from the sale of carbon credits a decisive factor in decision to proceed. |
| Gaming | GHG emissions not generated for the purpose of subsequent abatement to claim carbon credits. |

Aspects covered by additionality tests vary between mechanisms and standards. By far the most prevalent of the tests incorporated in existing additionality protocols under the CDM and the six voluntary carbon standards considered are compliance and barrier tests (see Table 2).

Differences in types of tests appear unrelated to whether carbon certificates are issued ex-post or ex-ante. This is illustrated most clearly by the same additionality protocol being applied in both cases under CarbonFix (see also comparisons in Tables 2 and 3). However, coverage, methodology and evidence requirements of specific types of tests vary between standards.

Trade-offs exist between the rigour and cost of additionality tests. Differences in tests applied partly relate to these trade-offs. This is illustrated by the different tests applied to large-scale and small-scale projects under the CDM, as well as the different approaches to establishing baselines.

These trade-offs can affect both the quality and number of projects approved. In a context of asymmetric information between sellers and buyers of carbon certificates, buyers are likely to have greater confidence the more rigorous the additionality tests applied at project level. However, more rigorous tests will generally involve higher transactions costs for project developers and could reduce the number of projects seeking certification. To the extent that higher transaction costs lead to some projects that would pass more rigorous tests not being put forward, it will tend to reduce the overall climate change mitigation benefits obtained. This suggests a delicate balance between underpinning the quality of carbon certificates and market confidence on one hand, and maximising the expected overall climate change mitigation benefits on the other. Akin to Heisenberg's uncertainty principle (the impossibility of exactly measuring both the position and velocity of an object simultaneously) perhaps, applying more rigorous additionality tests could serve to reduce net GHG savings in some instances.

Inclusion of tests for aspects of additionality of most interest to buyers affects demand. In the absence of perfectly elastic supply this influences the price of certificates in carbon markets and thus incentives for future development of projects. To the extent that it is a concern to prospective purchasers, the lack of a mechanism to ensure institutional additionality could be a disincentive to developing woodland carbon projects in countries such as the UK and an impediment to climate change mitigation by the forest sector. From a public perspective, however, the trade-off between securing extra GHG abatement and the extra cost of implementing and administering such a mechanism is not necessarily straightforward. There may be increased costs of reaching national abatement targets if some woodland projects are no longer counted and other public incentives are needed. Furthermore, the extent to which these costs divert public expenditure from alternative uses resulting in a reduction in GHG abatement elsewhere in the economy is also relevant. The current government approach in the UK is to view woodland projects as contributing to meeting national GHG targets rather than as providing carbon credits that can be traded as offsets.

In considering which approach to apply, developers of carbon standards and public authorities could benefit from greater clarity about distinctions between the different aspects and the potential for perverse incentives associated with some tests. Precisely specifying which tests for additionality and associated institutional arrangements are best is not easy from first principles without detailed consideration of the associated costs and benefits. However, even where such information exists or can be reliably estimated, it may not help much in specifying criteria such as cut-off dates, or thresholds for inclusion or exclusion of projects. To the extent that the concept of additionality is open to interpretation and based upon comparison with a hypothetical scenario, its determination is necessarily imprecise and is likely to remain controversial, even where comparatively stringent tests are applied.

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