TIME PREFERENCE, COSTS OF CAPITAL AND HIDDEN COSTS: A COMMITTEE ON CLIMATE CHANGE NOTE

1. The core principles on which public sector economic appraisal should be based, and which the Committee aims to follow, are set out in HM Treasury guidance in the Green Book[1].

2. The Green Book recommends that the Social Discount Rate (SDR), 3.5% - representing the value society attaches to present, as opposed to future, consumption – should be used as the standard real discount rate.

3. Nevertheless, there are complexities around both the appropriate rate to use and practical application of the guidance, particularly for projects where private resources are being used to deliver social objectives. The appropriate discount rate for use in option appraisal is a recurring issue raised in our modelling and in consultancy projects. Depending on the rate used there can be significant differences in estimated cost effective abatement potential. The purpose of this note is to provide further guidance for those engaged in such modelling work for the Committee.

4. The note is set out in four sections:

    i. Background: this section distinguishes social and private cost-benefit analysis. It sets out that the approach to use, and costs to include in appraisal, depends on the type of project being assessed and whether interest is in the cost-benefit to society (the UK as a whole) or to the private investor.

    ii. Project types: this section summarises the approach to be used for public sector projects and for projects with public objectives delivered by the private sector. It distinguishes the private cost of capital from the social discount rate.

    iii. Cost of capital by sector: for public projects delivered by the private sector, this section summarises evidence on the appropriate cost of capital.

    iv. Private sector decision rules and hidden costs: this section looks at a set of issues that may help to explain why private decisions are frequently seen to imply much higher rates of return than the sector cost of capital.

5. Compared with the theoretically preferred approach, for practical application of guidance some simplification is likely to be necessary. In summary, the recommended approach[2] is set out in the table below:

[1] http://www.hm-treasury.gov.uk/d/green_book_complete.pdf

[2] The approach here is broadly in line with the approach adopted in the Committee's 1st report in December 2008 in which: the social perspective was proxied in standard appraisal using the 3.5% SDR; for private sector projects a risk-adjusted rate was used (generally 10% for most power sector options); for domestic energy efficiency a sensitivity at 10% real was conducted; for surface transport, a "private motorist" perspective was considered using 7% real, and allowing for fuel duty saved (e.g. from take-up of EVs) as a benefit.

Social cost benefit analysis[3]	
Public sector project delivered using public funds	3.5% assuming risk free returns. Adjust costs rather than the discount rate where returns are uncertain.
Private sector delivery of public policy objectives	Two approaches are appropriate: • Same approach as the Green Book (i.e. use a 3.5% discount rate and adjust costs to reflect uncertainty). • Use a private cost of capital, as a proxy for costs associated with uncertainty and opportunity cost. The Committee has used both approaches, appraising options at social and private discount rates. The following private discount rates are appropriate: • For business, the private cost of capital (7-10%). • For individuals, borrowing costs (3.5-7.5%).
Private investment appraisal	
Private sector delivery - Interested in whether private sector (individuals or companies) will adopt technology	Include private sector cost of capital/required rate of return; typically this may mean discounting at rates more like 10 or 15% (before consideration of hidden costs); costs should be inclusive of taxes.

[3] All rates here are real terms.

i. Background

6. The Committee is interested in two types of cost-benefit analysis:

    - Social cost-benefit analysis: used to assess whether an investment represents a good use of society's resources. This requires investment to generate a return at least equal to the social discount rate to compensate for consumption foregone.

    - Private cost-benefit analysis: used to assess whether the private sector would adopt a particular measure. Taxes and private sector costs of capital will affect these decisions. For example, high taxes on fossil fuels may make investments in Electric Vehicles (EVs) worthwhile to the private sector, even if EVs fail to pass a social cost-benefit test.

7. A complexity arises when the public sector uses private resources to deliver social objectives. In this case the public sector may transfer risk on to the private sector – which is a genuine resource cost. Also the opportunity cost of using private sector resources may be greater than the social discount rate.

8. Given the different figures that abound in the literature, it is easy to see why there may be some question about the appropriate discount rate to use:

    - Green Book guidance - largely focused on appraisal of public funded projects - recommends using the social discount rate (SDR) of 3.5%[4]. This is a risk free rate.

    - Private sector cost of capital typically ranges between 7-10%

    - Private sector decision rules (payback periods etc) frequently imply required rates of return more like 20-25% (or more).

9. For appraisal purposes, the appropriate rate to use and basis of costs to include depends on the question being asked:

    - the type of project being assessed (public or private sector financed or delivered)

    - Whether the interest is in cost/benefit to the UK as a whole (does the project look good from a social perspective), or to the private investor (will the project go ahead).

[4] The SDR reflects society's preferences over time - that society prefers consumption now over the future, reflecting (a) society will be richer in future so the enjoyment received from the marginal £ is lower; (b) an element of pure time preference (impatience); (c) risk that society won't be around to enjoy the future £1.

ii. Project types

Public sector projects with certain returns

10. Green Book guidance is very clear for public sector projects where we are looking at social cost-benefit analysis (what is best for the UK) – use the SDR of 3.5% representing society preferences over time. For very long-lived projects – over 30 years – the schedule of declining discount rates in the Green Book should be used.

11. Public sector projects will be funded from taxation. There is the possibility that the social opportunity cost of exchequer (public) funds (SOCEF) will be greater than the amount raised through taxation. This would reflect that taxation may induce distortions to optimal resource allocation. There is, however, no agreed basis for a specific factor to represent SOCEF and it is not represented in the Green Book. The Committee does not therefore take this into account.

Public sector projects with uncertainty

12. Green Book guidance recommends taking account of risks by taking expected values of cashflows rather than adjusting the discount rate. There can be issues around applying this in practice, but this is the approach recommended by the Committee wherever possible.

Projects delivered by the private sector

13. For projects delivered by the private sector (companies, households), one approach is to follow the Green Book (i.e. use a social discount rate, and adjust costs).

14. An alternative approach follows guidance in a paper by Oxera[5] for Defra. This recommends inclusion of the appropriate private sector "cost of capital". The rationale for this is:

    - Transferring delivery to the private sector has costs
    - The private sector will require compensation for this risk
    - The required compensation can be represented by the agent's cost of capital (this will vary depending on the sector, reflecting different levels of risk)
    - This compensation should be included on the costs of the policy (at the time it is recovered from customers) and discounted back to present values using the SDR of 3.5%.[6]

15. There is merit in both approaches:

    - Using a social discount rate is appropriate to identify social priorities, assuming that costs can be adjusted to reflect uncertainty.

[5] Economic analysis for the Water framework Directive – Discounting and the calculation of the present value, Oxera, October 2006.

[6] This is consistent with the thrust of the Green Book. The SDR is a risk free rate; the Green Book envisages adjustment of cash flows to account for risk rather than adjustment of the SDR.

- Using a private cost of capital/discount rate provides insights into costs associated with uncertainty and opportunity costs. However, it is important to note that the private discount rates also signal other factors such as availability of finance, creditworthiness of individuals and firms and corporate priorities.

16. We have therefore used both social and private discount rates in our analysis:

    - For example, in our assessment of heat pumps and electric vehicles, we use a social discount rate and consider sensitivities based on a private discount rate.
    - In our assessment of power generation, we follow the convention, and use a private discount rate, considering a social discount rate sensitivity.
    - We also consider very high discount rate sensitivities to model hidden costs (see Section iv below).

17. Where a private cost of capital/discount rate is to be used, this leaves the question of the appropriate rate to use.

iii. Appropriate cost of capital by sector

18. The cost of capital varies across sectors reflecting differences in risks inherent in the activities of companies in the sector concerned. This will reflect, for example, differences in ability to pass through costs to consumers, itself a reflection of market structure and price elasticities for the product in question.

19. The main method used to calculate an appropriate cost of capital is the Capital Asset Pricing Model (CAPM)[7]. This predicts that the risk premium applicable to any security is a linear function of the risk premium on the market portfolio, as in:

$$E(R_i - R_f) = \beta_i \, . \, E(R_m - R_f)$$

where $E(R_i - R_f)$ denotes the expected return on a particular security over and above the risk-free rate (i.e. the expected excess return on a security); $E(R_m - R_f)$ denotes the expected excess return on the market portfolio; and β_i – the investment beta – is the coefficient that captures the exposure of the security to "systematic risk" (the risk that arises from exposure to risks inherent in the market as a whole).

20. The fundamental point in this framework is that investors are only compensated for their exposure to systematic risk – reflecting an assumption that risks which are not correlated with the market ("non-systematic" or "idiosyncratic" risk) can be diversified away.

21. In empirical tests the CAPM has not performed strongly. This may reflect that it relies on a number of strong assumptions that may not hold in practice. And, as the ranges below show, there is a wide range of uncertainty associated with estimates.

[7] This section draws on Oxera (2011), "Discount rate for low carbon and renewable generation technologies", which contains further detail and an assessment of the CAPM. [http://hmccc.s3.amazonaws.com/Renewables%20Review/oxera%20low%20carbon%20discount%20rates%20180411.pdf]

22. Based on UK market evidence using the CAPM and wider international evidence, Oxera[8], suggest estimates for the weighted average cost of capital in the range 3.5 – 10%:

Agriculture	3.9-7.3
Water	3.5-5.8
Urban and transport	3.7-6.9
Navigation	4.0-5.7
Fisheries and conservation	3.8-6.1
Mining	4.5-7.5
Other industry/business	4.5-9.8
Chemicals and oil	*4.5-9.8*
Construction	*4.8-6.5*
Waste management	*4.7-5.3*
Recreation (eg parkland, amenities)	*4.7-6.2*

23. Recent Mott Macdonald levelised costs work for DECC has used 10% across the board for generation technologies, with a sensitivity at 7.5%.

24. Oxera (2011) provides advice in relation to generation technologies. They note that the cost of capital for a stand-alone project may not typically coincide with the overall cost of capital for the firm undertaking the investment;

> "The risks associated with some low-carbon generation projects would perhaps be expected to vary greatly from firms' (or investors') overall operations seen as a portfolio of projects, particularly if they involve large capital expenditures that are also "lumpy" (e.g. nuclear new build), or based on unproven, nascent technology".

Thus, there is a social risk in investment in a nascent or emerging technology reflecting that the costs or performance of such technologies may not turn out as expected.

25. For established dispatchable technologies (e.g. unabated gas, hydro) Oxera (2011) estimate pre-tax real rates around 6-9%. For less mature technologies, which includes most low-carbon technologies, they estimate that higher rates are currently applicable (e.g. 10-14% for offshore wind). They suggest that deployment over time, and supportive policy, could reduce costs of capital for immature technologies. In the long term this suggests that costs of capital for low-carbon technologies could be comparable to unabated gas today.

[8] Economic analysis for the Water framework directive: Estimating the cost of capital for the cost-effectiveness analysis, financial viability assessment and disproportionate costs assessment – Phase II, Oxera, 2007

26. Overall, the evidence in power and industry suggests that a real post-tax weighted average cost of capital (WACC) around 7-10% is reasonable (possibly lower in heavily regulated industries). In the power sector, use of 10% across technologies and time periods should be accompanied by sensitivities using a lower rate, say 7.5%, with an expectation that rates for low-carbon technologies could fall as these become more mature over time.

27. For the domestic sector, the range of rates for different types of borrowing is large. Market leading loan rates for low risk individuals are currently in the region of 7.5%, which would indicate a real cost of capital fairly close to 3.5%. For others, the cost of capital can be much higher – rates on credit cards and other forms of unsecured lending, for example. For social cost-benefit appraisal, use of the 3.5% SDR is recommended, but with sensitivity at a higher rate, 7.5%.

iv. Private sector decision rules and hidden costs

28. In practice, private decisions are frequently seen to be taken implying much higher required rates of return (short payback periods) than sector or household costs of capital. The point here is that a number of different factors may contribute to such rates - a threshold rate of return of 15-25% (or more) should not be taken as representative of a high financing cost.

29. Identifying the main contributory factors matters as to:

    - Whether these are costs to include in social cost-benefit

    - Policy design. Such costs might be real, but the project/policy being appraised might be able to reduce them.

30. For some of these costs, broad estimates of their value are available (eg. work by Enviros, Ecofys, Element Energy). In so far as possible, where these are real costs these should be included as costs in the appraisal, with discounting back to current values using the SDR, rather than concealing them within a higher discount rate. Whether these are real social costs, and whether they can be reduced through policy design, requires consideration in relation to the specific policy/technology in question. In summary::

Nature of cost/barrier	**Recommended treatment**
Hidden costs (eg. searching for information; opportunity cost of board-level time; hassle costs of disruption attached to installation; loss of space)	Real costs. Ideally, to extent these costs are not removed or reduced through policy design, include estimated value within costs/benefits being appraised. Where estimates unavailable, case by case consideration of the nature of these costs and their significance. Can they be reduced through policy design? e.g. centralised information provision, product standards, installer accreditation schemes or training, co-ordination of installation with other

	measures or investment timetables
Risk and uncertainty (eg. don't know future energy prices and therefore savings from energy efficiency investment; irreversibility – once invest, bound in and lose option value; uncertainty of performance of new product; project risks that installation causes problems).	Real costs. Can't be diversified away. Some elements might be reduced through increased familiarity with products over time and product standards)
Uncertain that will be resident in house longer-term to gain from eg. energy efficiency investment (asset life exceeds private perspective on time to break-even).	Market failure (reflecting improvement not capitalised in house value). Not social cost (social CBA should reflect the lifetime of the asset) but affects uptake decision.
Poorly aligned incentives (eg landlord-tenant)	Market failure (principle-agent problem). Not social cost but affects uptake decision.
Inertia, habit, bounded rationality, consumer irrationality; some evidence that people are risk averse and place higher weight on possibility of unexpected loss than of gain (prospect theory)	Not fully social cost, but affects uptake decision. Should be scope to reduce inertia and habit through increased familiarity, starting with easier populations, and through information provision (e.g. publication of success stories). Policy design might also try to take account of bounded rationality – make decisions as easy as possible. But if people weigh costs higher than benefits (e.g. the cost of "regret") this might be considered a real cost - the fair gamble would not be perceived as fair by such a decision maker so forcing it on that individual/household looks like imposing a welfare loss Regulation which requires adoption of specific measures may reduce or eliminate these behavioural costs.
High up-front financial cost (eg. limited access to financing for lower income households, small business)	Affects uptake decision, redistribution policies are the first best option to address the problem.

31. Where these costs are real, but cannot be estimated then this may justify use of a higher rate of return (to proxy that some costs are missing). But there is some evidence that hidden

costs are an important reason[9] for observed required rates of return at 15-25% (more important than other factors above). If that is right, there is not a good justification to include hidden costs in appraisal and require returns at the higher end of the range.

32. Note also, there may be hidden benefits, eg positive health impacts. A report for DECC by Ecofys[10] notes the possibility but also that evidence on quantification is worse than for costs.

Summary

33. In summary, the approach which the CCC aims to use is to be consistent with the Green Book. For appraisal from a social perspective this means discounting of costs and benefits in line with the social discount rate (3.5%). Risks should be accounted for by taking expected values of cashflows rather than adjusting the discount rate. For public projects delivered by the private sector (i.e. private sector delivery of public objectives), this approach remains appropriate. However, it can usefully be complemented by assessment using private discount rates, in order to allow for risks, opportunity costs, and hidden costs.

[9] Eg. Metcalf and Hassett (1999) find once all costs allowed for realised returns to loft insulation were much below those promised by engineers/manufacturers and close to rates suggested required by investment theory; UK "Barriers" project (in depth analysis of a few specific industries) found economic factors around hidden costs and access to capital were the most important factors.

[10] The hidden costs and benefits of domestic energy efficiency and carbon saving measures, Ecofys May 2009