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Economic Incentive Schemes for Retrofitting London's Existing Homes for Climate Change Impacts

Copies of this report are available as an electronic download from:
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Any recommendations in this report reflect the views of the London Climate Change Partnership developed during the course of this study, and do not necessary reflect the views of the individual members of the Partnership.

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EXECUTIVE SUMMARY

This study was commissioned by the Greater London Authority on behalf of the London Climate Change Partnership (LCCP). It explores the possibility of developing economic incentive schemes to promote retrofitting of the London housing stock to adapt to the impacts of climate change. It builds on a previous report (2008) commissioned by the LCCP with other partners: *Your Home in a Changing Climate: Retrofitting Existing Homes for Climate Change*, which concluded that it was possible to cost-effectively retrofit existing housing to adapt to climate change impacts of increasing flood risk, overheating and water scarcity. One of its key findings was that incentives were necessary to make this happen as 'cost represents one of the most significant barriers to adaptation for householders'.

The development of incentives can be justified on the basis of three main types of market failure:

- Lack of information on the physical and economic benefits of adaptation to climate change, that is actively given to households and existing housing related sectors,
- Lack of short-term or direct benefits from an adaptation retrofit, which can act as a barrier to initial investment and refurbishment actions by individual householders, despite the existence of wider social benefits.
- In some cases, lack of access to finance to put in place investments which have positive returns, either individually or socially.

Furthermore, incentives are recognised[1] by Government as a key part of any package of measures to promote behaviour change through encouraging action.

To help develop economic incentive scheme proposals and recommendations, firstly a number of international incentive scheme case studies were examined for their applicability to London. Secondly, input from key London sectors and organisations identified and steered individual proposals to suit several essential retrofitting needs for London.

The study identifies and examines international economic incentive schemes that:

- Increase **water efficiency** and reduce water wastage
- Reduce the risks of **flooding** and the impacts of flooding
- Improve the resilience of housing to **overheating**

These are the key areas action required for climate change adaptation described in the *Your Home in a Changing Climate* Report above. Given the relatively recent interest in climate change adaptation, there are no established incentives addressing it holistically, but case study material does exist for incentive schemes addressing the specific areas above.

From the case study analysis and discussions with key stakeholders and steering committee members, the study identified 2 specific areas where economic incentive models could be developed for London in the short term:

- Grants for **Green Roofs** to address overheating and surface water flooding risks; and
- Subsidies or Grants for **water efficient toilets** and **showerheads** to improve water use efficiency reduce domestic hot water carbon emissions.

[1] See the Chapter 2 on behaviour change of the HM Government (2005) Securing the Future: Delivering the UK Sustainable Development Strategy.

For the longer term, the study has identified a range of wider lessons which need to be taken into account in designing perhaps more holistic adaptation incentives:

- The willingness and ability of different stakeholders to take action on adaptation;
- The use of fiscal, regulatory and wider behavioural incentives beyond those considered from case study examples; and
- The need to make linkages between the adaptation agenda and other agendas such as mitigation and water conservation.

Key findings

Incentive 1: Green roofs – in the light of an indicative cost-benefit analysis, which only partially accounted for a number of environmental benefits that would be associated with an increase in the number of green roofs in London, a subsidy of **~£17 per m^2** would appear reasonable. This would be justified by the quantifiable environmental benefits from installing green roofs[2] and hence the costs of the scheme will equal the benefits. A scheme for four inner city areas - Cannon Street, Oxford Street, Tottenham Court Road and Canary Wharf – with a green roof area of 226,750m^2 would cost around £4 million and provide environmental benefits[3] worth £4 million. A wider scheme covering the City of London, part of the London Borough of Hackney, part of the London Borough of Tower Hamlets and part of the West End with a green roof area of 3.2 million m^2 would cost around £55.5 million and provide environmental benefits worth £55.5 million. A potential green roof grant could also be incorporated into a wider homes retrofit programme to improve energy and water efficiency in existing domestic stock.

It would also be reasonable for the GLA to coordinate, and at least part fund green roof grants given its remit. Potential funding streams could also include:

- The Innovation and Opportunity Fund element of the 2008-11 regional housing fund; and
- The JESSICA (Joint European Support for Sustainable Investment in City Areas) EC funding secured by the LDA (2007-13).

It would be worth examining whether the incentive scheme should be based on grants or loans, similar to those previously used by the London Climate Change Agency for mitigation measures. Funding could possibly be jointly administered with councils with the greatest potential to benefit from green roofs. Given the benefits of storm water management and energy saving, utility companies could also be involved in funding a green roof programme.

Incentive 2: Water Efficiency – on the basis of a cost-benefit analysis, and information and assumptions on London water fittings, a five year programme could be proposed offering:

- a grant/subsidy of **£44** to any consumer choosing to buy a very water efficient toilet (eg. single-flush 4.5 litre siphon toilet), based on the reduced costs to water utilities due to the resulting water savings. This might be expected to increase the penetration of such toilets from 2% in 2009 to 9%, based on international case studies, of total toilet purchases in 2013, saving 9,200 ML over the lifetime of the

[2] The main public environmental benefits not quantified are public health, aesthetic and biodiversity benefits.

[3] Stormwater management, Combined Sewer Overflow, Air Quality, Urban Heat Island, Greenhouse Gases and Food Production.

products - 16.5 years[4]. This equates to 557ML on average saved each year. The value of grant/subsidy of such a scheme would be £6.5 million (£8 million including administration and marketing) over 5 years providing rebates for 148,000 toilets of which approximately 82,500 would be additionally purchased due to the subsidy.

- a 100% grant/subsidy of costing **£10** each to any consumer choosing to buy an water efficiency showerhead based on the reduced costs to water utilities due to the resulting water savings and the assumption that retailers would be willing to supply these showerheads at no mark-up. It is estimated that this could increase the penetration of such showerheads to 80% of total replacement showerhead purchases in 2013, saving 67,000 ML over the next 10 years. This equates to 6,700 ML on average each year. The incentive does estimate a relatively ambitious take-up of showerheads as they would be free at the point of sale compared to the low efficiency alternatives. The value of grant/subsidy of such a scheme would be £9 million over 5 years provide rebates for 916,000 showerheads. This will also save 405,000 tonnes of carbon over 10 years (on average 40.5t / yr) due to the reduced energy use from the reduced use of hot water, saving customers on average £41 per year on their energy bills.

The sectors and organisations that have a potential role to play in funding and/or implementing these proposed schemes, include water and energy utilities, existing low-carbon schemes, plus central, regional and local government levels. The water companies would benefit through reducing their costs of supply, as part of their water efficiency targets and own corporate objectives. The energy companies would benefit in securing customer base and achieving CERT targets. All Government levels would benefit from reporting reductions in carbon emissions related to hot water use within their area.

Funds for both toilet and showerhead grants/subsidies, could also be considered for incorporating into a wider pan-London homes retrofit programme, to improve energy and water efficiency in London's existing domestic stock.

Recommendations

The main recommendations arise from the above development of detailed models of incentive schemes for London, through the study's development and steering group involvement:

- The LCCP and its partners facilitate and/or lobby key sectors / organisations to implement pilot projects to further test efficiency and effectiveness of incentive schemes for green roofs and water efficiency devices. Particular attention should be given to calculating London-specific costs and benefits of green roofs which are not currently available.
- Central Government, Regional and Local Authorities, energy and water utility companies, and housing groups should investigate how these incentive schemes could deliver their adaptation and mitigation targets. It is recommended that combined sector or partnership working utilise existing or proposed pan-London carbon-reduction and/or refurbishment programmes.
- Energy utility companies should explore the benefits of introducing incentive schemes for water efficiency measures that deliver carbon reduction benefits. Energy utility companies could investigate using water efficiency incentive schemes to help deliver their Carbon Emissions Reduction Target obligation (CERT) within London.

[4] BN DW WC: Actions to improve water closet design and efficiency - Briefing Note relating to Policy scenario objectives in Policy Brief Hwww.mtprog.com

- Central Government should continue efforts to allow VAT flexibility for better performing water efficient devices and appliances.

Other recommendations have arisen from the analysis and discussion of case studies:

- Central Government should introduce or support a single ranked Water Efficiency Labelling Scheme for all water using devices and appliances, to help support the implementation of economic incentives mechanisms for water efficiency.
- Defra's recently announced extension to their flood resilience programme should be carefully monitored to review the properties eligible for funding and the nature of flood risk covered – to include specific areas within London at risk of surface water flood risk – following development of the National Surface Water Flood Risk Mapping programme.
- Risk based pricing should be the guiding principle of insurance pricing around the world; where this is prevented by regulation these restrictions should be removed. The insurance industry should consider how the financial benefits of adaptation can translate into differentiated pricing; to encourage adaptation. Well and timely communicated, risk focussed, building codes requiring adaptation and the use of appropriate sustainable materials should apply to high risk communities when buildings are extended or when work is undertaken after a material insurance claim (e.g flood)."
- The UK water regulatory framework needs to transform it's set-up and focus so that long-term sustainability of a product is on par with security of supply. This will allow water utility companies to better value demand management of water and cost effectively implement water efficiency programmes.

It should be noted that the incentive mechanisms identified or recommended in this study, are by no means an exhaustive list or the only options available. The case studies reviewed made were chosen by the project group as an initial demonstration of what economic incentive schemes could be investigated, within the defined scope and budget of this project.

1 INTRODUCTION

1.1 Introduction

Research on public attitudes towards climate change has, in recent years, revealed an awkward and potentially inconvenient truth: while most people believe that climate change is a real and serious threat, few people are inclined to do anything about it[5]. Simply lambasting people to change – whether as householders, consumers, employees or employers – is unlikely to be effective: and in acknowledgement of this, work is underway (much of it taking place within Defra) to explore and understand the barriers that prevent both individuals and companies from changing their behaviour, and to devise strategies, policies and programmes that can steer the economy to a low carbon footing.

If the problems of intransigence are acute in the case of climate change mitigation, they are even more severe in the case of adaptation. For the former, a sustained narrative from both government and the media over the past few years has begun to establish in people's minds the connections between the cars they drive, the holidays they take, their lifestyles at home, and the consequences for the climate. Action may still be limited, but awareness is high.

In the case of adaptation, however, the threats of future droughts, floods and storms are, for most people, far in the future. There will always be uncertainty and people are often unaware of adaptation methods and benefits. Most people and most businesses have short time planning horizons and are focused on short-term priorities. This is where a financial 'helping hand', or incentive, can assist in providing adaptive capacity.

Greater and more robust evidence now available on likely climate change impacts makes it ever more pressing that action is indeed taken. By 2050 in London, it is highly likely that more extreme weather, including both hotter summers and droughts, and heavier storms and flooding, will characterise normal life. To prevent discomfort, expensive damage, property values and – for some – premature death, our built environment will need to function very differently from how it does today.

Since so much of the built environment of 2050 already exists – particularly in terms of residential housing – there is clearly an imperative to find ways to 'retrofit' properties to adapt to climate change impacts and generally improvement their sustainability. The Three Regions Climate Change Group (TRCCG)[6] report, *Your Home in a Changing Climate* identified and costed the key items for adaptation retrofitting. The challenge now is to find the mechanisms to encourage and enable individuals, private landlords, housing associations or local authorities to make the necessary changes?

Innovative and creative policy is called for; and it has begun. At national level, Defra's "Adapting to Climate Change" programme is in the foothills of its first phase, and the new Committee on Climate Change has a sub-committee specifically devoted to adaptation; at regional level, there is a new 'Local and Regional Adaptation Partnership' bringing together learning and experience from across the country; while the draft London Climate Change Adaptation Strategy (August 2008) and The London Housing Strategy (draft consultation, 2008) highlight the need to improve adaptation within existing housing stock..

In this context, the London Climate Change Partnership – which has been leading on adaptation issues since 2001 – is following on the *Your Home in a Changing Climate* report

[5] See e.g. Defra/BMRB 2008, Ipsos Mori 2008, Brook Lyndhurst for Defra 2008

[6] TRCCG, Your Home in a Change Climate (2008)

by investigating what kinds of *economic* incentives might encourage the more rapid uptake of adaptation measures among residential property owners in London.

GHK, with support from Brook Lyndhurst, was commissioned to conduct research to investigate this question. The findings presented in this report provide a mix of descriptive insights, quantitative analysis and items for discussion. It is hoped that this material provides the basis for both detailed development of potential incentive programmes as well as further debate and discussion within LCCP and among its stakeholders.

1.2 Approach

There were three stages of the research:

1. Investigation of a wide range of case studies from around the globe, of where economic incentives had been used to accelerate the uptake of various adaptation measures;

2. A detailed review of schemes of particular relevance to London;

3. Development of propositions for how specific measures could be taken forward in the capital.

1.2.1 Initial Case Studies

A review of international incentive schemes was undertaken. The list of resulting potential case studies is located in Annex 1.

We assessed the potential case studies identified against the following criteria:

- Relevance to improving climate change adaptation of the London housing stock
- Similarity of governance arrangements to London and ability to implement by London's governance, finance and utility bodies
- Quality and quantity of information on the case study (e.g. has the scheme been independently evaluated?)

These were then reviewed with the project's Steering Group to agree a shortlist for further detailed study.

1.2.2 Detailed Case Studies

A wide range of well established and documented examples of economic incentive schemes to increase water efficiency and reduce water wastage were found. A limited number of less well-documented schemes in the other two areas were also identified. There was particularly a lack of examples of incentives to improve the resilience of housing to overheating as this is a relatively newly identified issue, although there were a range of examples of incentives for green roofs, which have a range of benefits including reducing overheating. A key challenge was identifying schemes ro incentive examples that were transferable to London's governance and regulatory framework.

Five case studies were identified as relevant to London's adaptation improvement within existing housing stock, and that had adequate information and data to evaluate their efficiency and effectiveness. Then through detailed analysis of these case studies, relevant lessons were used to design model schemes for London including assessing their costs and benefits. Consideration has not been given to every possible incentive scheme, but rather the best documented international practice and has helped develop outline recommendations for London equivalent schemes

From the wider range of examples, we chose a limited number with most potential relevance for London and with good data to inform a London model:

- The Toronto Green Roof Pilot Incentive Programme, Canada;
- Various City Rebate Schemes for water efficiency and conservation;
- A UK Flood Resilience Pilot Funding Scheme;
- The Calgary Water Meter Installation Programme, Canada; and
- The National Flood Insurance Programme, USA.

These are analysed in detail in the annexes.

The shortlist focused on three themes, selected partly to illustrate the breadth of issues and partly because the climate change impacts for London are expected to be significant:

- Reduce the risks of flooding and the impacts of flooding;
- Improve the resilience of housing to overheating;
- Increase water efficiency and reduce water wastage

A standard template was developed to analyse the case studies including, as far as available:

- Context: political, societal and economic drivers and challenges
- Inputs: costs and governance arrangements
- Activities: design, marketing and operation of the scheme
- Outputs: levels and types of incentives delivered, geographical scope
- Outcomes and Impacts: take-up of schemes, changes in behaviour and how sustained they were; environmental and monetary benefits; winners and losers
- Lessons: barriers and how they were overcome; sustainability of behaviour change.

From this analysis of case studies, an initial comparative assessment was done to determine their success and 'fit' with London, or how London might learn from these incentive schemes.

1.2.3 Developing Propositions

In the final part of the work, we developed propositions of two kinds:

- general propositions arising from the analysis that relate to the broader programme of incentivising adaptive change among residential property owners;
- specific propositions for two schemes – associated with "addressing overheating and surface water flood risk" and "water efficiency" – that flow directly from the case study analysis. These propositions set out:
  - the key design parameters for the London scheme including the governance, types of housing stock/households targeted, levels and types of incentives, operation and costs, funding levels for incentives
  - possible barriers and how they might be addressed
  - potential ancillary measures to ensure effective behaviour change in line with the Encourage – Exemplify – Engage – Enable framework
  - estimates of behavioural impacts and monetary benefits, where feasible, and analysis of distributional benefits.

1.3 What this study does and doesn't do

Most studies on incentive schemes for behavioural change have been on mitigation measures. This study has attempted to analyse, though partially, incentives schemes for adaptation measures. There are many things this research did not do. It did not, for example, consider all the possible measures that could conceivably be taken to address the urban heat island effect, and from those choose 'green roofs'; it did not consider the possible maximum market size for low water toilets and then devise a pilot scheme intended to launch towards such a size; nor did it investigate all the possible behaviour change techniques that, alongside financial incentives, might maximise the chances of adaptation uptake.

Rather, on the basis of experiences elsewhere in the world, and the specific structural and institutional issues operating in London, it worked towards and then detailed the kinds of economic incentives that could form the basis of specific programmes in London (a) to increase the uptake of green roofs (b) to increase the market share of low-water toilets and water efficient showerheads.

In narrowing down to these specifics, the research – and the discussions around the research – nevertheless touched on a wide range of issues that pertain *in general* to the challenge of incentivising adaptation measures, and we present a discussion of these issues below.

1.4 Discussion of Wider Issues

1.4.1 The 'market' for adaptation and market failure

A free market perspective on adaptation measures would begin by noting that rational economic decision makers choose whether or not to adopt any given adaptation measure on the basis of a rational calculation. The present costs of adaptation (e.g. the cost of installing a green roof and installing water efficient items) are measured against the expected future benefit stream, compared to one or more alternatives, and a choice can be made on the basis of economic viability. The fact that so few individuals and companies have so far adopted those sustainability measures simply tells us, it would be claimed, that such measures are not yet needed. When they are, independent agents operating in a free market setting will be able to make the choices that best suit their needs.

Critiques of such a perspective might argue that some sort of 'market failure' is, in fact, taking place. After all, the evidence about the prospective impact of climate change is overwhelming. The 'market failure' argument could therefore rely on one or more precepts such as: individuals may have inadequate or asymmetric access to correct information, such that they are systematically making incorrect decisions; there may be some factors (such as externalities) which do not enter the cost/benefit calculation; and so on.

Consider, for example, a case in which an individual householder is considering installing flood protection measures. The costs of the installation may appear transparent, since they comprise merely the financial cost of installation. But there is more to it than this. An individual householder may consider, for example, the possible impact on the value of the home if they install a protective device. On the one hand, the value of the property may go up, because potential buyers will acknowledge that protection from future floods reduces the risk of incurring future costs, which have a present value, and will pay a premium accordingly.

On the other hand, the negative impacts on visual amenity and the clear signal that 'This property is at risk from flooding' may reduce the willingness to pay of potential buyers, and act to suppress or even decrease the value of her home. The costs of installation, in this case, may be larger than they at first appear, and considerable.

A similar dilemma will apply in the case of commercial owners of residential property. Will the value of your portfolio rise or fall if it is covered in green roofs? Will you be able to command higher rents (because tenants are persuaded by the lower running and maintenance costs, or because occupying a 'green' building will meet a corporate social responsibility objective)? Or will you experience longer-than-average voids, because tenants are suspicious of anything too 'weird', with inevitable consequences for both cash flow and yields?

In the face of such uncertainty, and in the absence of established market or social norms (which might give confidence about which outcomes to expect and with what sort of probability), the individual decision maker is, in fact, being perfectly *rational* in deciding not to install a piece of adaptation kit. Hence there is a clear rationale for implementing incentive schemes to address these issues of market failure.

1.4.2 Other Market Issues

The dominant feature of the 'market' for adaptation is the time frame over which decisions apply. On the one hand, many of the actual manifestations of climate change are expected to occur gradually over a long period of time, with considerable uncertainty surrounding precise timing, scale, consequences and so forth. On the other, over the time frames involved, many of the variables underpinning decisions are themselves variable.

Most obviously, the ownership of residential property assets changes over time. This introduces a clear challenge: the costs of adaptation may be borne by one party, but the benefits may accrue to another. Thus, a householder may incur current costs to install a low volume toilet, but the benefits will be to a (future) water company in achieving water efficiency targets or offsetting new supply infrastructure; or a current landlord incurs the costs of installing a green roof, but the benefits accrue to future citizens of the city and future owners of the property and neighbouring properties.

This distribution of costs and benefits can act as a major block to the willingness of particular owners to invest; in general, those that incur costs prefer to receive benefits themselves. The longer the payback period, the less enticing any given investment will appear – and the more likely it is that over the duration of the investment's effect there will be some change in ownership of the asset.

This certainly emphasises the role to be played by institutions with longer time horizons. Many private home owners, many landlords and most property developers do not envisage having a [legal or financial] stake in a residential property in 20 or 30 years' time. Other institutions with stakes in residential property – housing associations, local authorities, some investment institutions, government agencies such as the DoH and MoD – may indeed have time horizons of this length, and ought – other things being equal – to be more amenable to the 'invest to save' argument.

The distributional issue has another important dimension, too: those most likely to suffer from the negative effects of climate change may be the people least able, willing or likely to take adaptive measures. Disadvantaged communities, for example, are typically at greater risk of flooding[7]: and older residents will be at greater risk of heat-induced ill-health; both groups, typically, have comparatively reduced access to the kind of resources (not merely financial) needed to take adaptive action.

Consideration of distributional issues is therefore central when considering whether and how to intervene to encourage and incentivise (more rapid) uptake of adaptive measures.

[7] See "Improving Poor Environments", Brook Lyndhurst for Environment Agency (2007)

Also central, and the second key feature of the 'market' for adaptation measures, are the characteristics of the various players involved.

1.4.3 Stakeholders

It is relatively straightforward to identify the key participants in the current context. More difficult is being clear about both the actual and the prospective distribution of responsibilities and their willingness to act.

This is, again, a generic problem in the arena of pro-environmental behaviour change, with ongoing debates about whether consumers, suppliers, government, local councils, the third sector, private companies or others should be 'in the lead'. There is, of course, no easy answer to this question. In the case of adaptation, however, given current legislative and institutional arrangements, the current low level of awareness of adaptation issues among the general public, and the general dislocation between those bearing costs and those likely to benefit, the onus would seem very much to be on the larger and longer-time horizon entities – government departments, regional and local authorities, utility companies, property and financial institutions.

In terms of the key stakeholder groups, our discussion focuses on the kind of engagement it might be reasonable to expect on climate change adaptation projects at present:

Private households – are clearly instrumental to the widespread and longer-term adoption of adaptation measures. In the short term, however, low levels of awareness and the kinds of rational decision-making discussed above suggest that it will be challenging to engage the attention of this group at present. Even the kinds of households that will put themselves forward for 'cutting edge' grant schemes will be idiosyncratic [i.e. they are likely to be passionate about the environment] and the engagement of these 'early adopters' may tell us little about a larger scale programme.

Private landlords – are likely to be exceptionally difficult to engage on this agenda. Although instruments such as the Landlord Energy Savings Allowance may be acting to raise awareness (and even, perhaps, change behaviour) the sector has shown little appetite so far for the 'invest to save' approach. Examples may nevertheless exist of private landlords who could be interested in implementing adaptation measures; but it would be unwise, in our view, to focus unduly on this sector in the shorter term.

Institutional landlords - including housing associations, public sector bodies with large residential assets (e.g. NHS and MoD) and, potentially, large-scale private sector investors, all have the potential to integrate adaptation within longer-term investment decisions; they therefore represent a potentially promising audience for the promotion of adaptation measures. Conversely, many of these organisations already receive State funding, and it may be that the kinds of financial incentive upon which this research has focused would be inappropriate as a means of encouraging the uptake of adaptation measures.

Local authorities – have a number of potential roles to play, in some cases as a landlord, in some cases as a funder, in some cases as a planning authority. In principle, for example, local authorities could introduce adaptation requirements within Section 106 arrangements; they could set up innovative loan funds to fund adaptation measures; they could investigate opportunities for Council Tax variations to incentivise both mitigation and adaptation measures. With LAA Target 188 ('planning to adapt to climate change') having been widely adopted and an adaptation 'duty' set to be a requirement of forthcoming Regional Strategies, there is likely to be considerable experimentation, learning and sharing of good practice on this agenda over the next few years. In the shorter term, however, the likelihood of especially innovative approaches from local authorities has to be questioned.

Utilities – are in a central and challenging position. From an 'invest to save' perspective within the confines of the current regulatory environment there are benefits for utilities to be a key player in promoting and delivering adaptation measures. The current water regulatory framework doesn't incentivise water efficiency as a stand-alone programme, however incentive schemes could be investigated by water supply companies to help achieve new water efficiency targets. The water efficiency case studies show that where the regulatory regime is compatible utilities have recognised this and directly funded incentive schemes or have been involved through partnerships. Energy utilities also have a potential role to play, as improving water efficiency has a win-win benefit of reducing carbon, through reductions to hot water usage. An energy utility company could potentially use CERT commitments on water efficiency incentive schemes.

Regulators et al – regulators specifically Ofwat (the financial regulator) and the Environment Agency (the environmental regulator) also have an important role to play. Ofwat require water utilities to justify the cost benefit of water demand management as against developing new supplies whilst the Environment Agency is central in terms of assessing the environmental impact of proposed options. As a consequence the role of the regulatory authorities in setting the parameters within which long-term investment takes place is central. If adaptation through improving water use efficiency is to become a priority for utility companies, and mainstreamed through capital and revenue investment, then the water regulatory framework needs to transform it's set-up and focus so that long-term sustainability of a product is on par with security of supply.

Property market professionals – are certainly in a position to have a direct effect. Since the focus of this research is on retrofit, the most obvious candidates for attention are developers and estate agents (rather than, for example, planners or architects). Do the former have the skills necessary to construct green roofs? Are the latter able to give sound advice on the impact on a property's value of a climate change adaptation? It is difficult to present an instantly optimistic picture: a consistent story from the UK's property sector in recent years has been the 'vicious cycle of blame', in which the various actors blame each other for the lack of progress on environmental or sustainability issues. There seems little evidence to date – and even more so in the current economic climate – of property valuations factoring in environmental issues. It seems unlikely that this pattern will be broken in the case of adaptation – but ways of working with the sector will need to be found.

Insurance sector – finally, the insurance sector has an especially vital position. Many of the financial costs of failure to adapt to climate change will either fall upon or be processed through the insurance sector. It therefore has a particularly strong interest in the costs and benefits of adaptation: conceivably, a more resilient housing stock will mean, in the longer run, lower payouts and greater profits for the insurance sector. Engaging with, or even leading techniques intended to accelerate adaptation ought therefore to be of interest to the insurance industry – and that is indeed what has been happening.

There are other stakeholders, of course, including the many companies that might manufacture, install and maintain certain adaptive technologies. We have not, for this study, discussed the supply side of, for example, green roofs [though we assume it remains a specialist niche activity] and it is possible that supply-side bottlenecks may emerge in due course. For the moment, however, we think it is safe to assume that there are no particular barriers to entry and that, once demand is forthcoming, the supply side will adapt accordingly. For present purposes, therefore, the main categories of stakeholder have been mentioned above.

1.4.4 *Incentives in principle*

The overall question thus falls into two parts: upon which stakeholders should the focus at this early phase in the adoption of adaptation measures be; and what sort of things might encourage those stakeholders to change their behaviour?

For the purposes of this study, our focus has been on the financial incentives that might encourage the owners of residential properties to invest in adaptation measures. Though there has not been a detailed investigation of alternative or complementary incentives, a broad sketch is possible. We distinguish three categories of incentive:

- fiscal incentives – use of the tax system, or the awarding of grants, subsidies or discounts
- regulatory incentives – amending the 'rules' so as to encourage adaptation
- other incentives – principally 'behaviour change' techniques

Fiscal incentives

Role of Central Government

Considering, firstly, central government, it is clear in principle that the taxation system could be used to alter the pattern of incentives. In principle, exemptions, variable tax rates and allowances could be used to send a signal that behaviour A (or, perhaps more accurately, choice A) is 'preferred' to choice B; and, indeed, this is precisely what happens, across a range of policy issues, including the environment (e.g. zero VAT on new building and books, variable vehicle licensing rates).

In the case of adaptation, however, practical considerations loom large. There are, for example, European restrictions on what can be done with VAT, in particular limiting the ability to send signals that differentiate between products within a category. It is presently not possible, for example, to lower the VAT on a low-flush volume toilet compared to a more wasteful alternative. In addition, HM Treasury are very much focused on broader economic issues at present, and such attention as is being accorded to environmental taxation is focused on mitigation rather than adaptation. Although innovative fiscal incentives may not be a primary focus in the short term, it is crucial that Central Government, in particular HM Treasury, continue to pursue change.

That is not to say that other central government sources should not be involved. As we saw in Chapter 3, Defra is making £5 million in the form of grants available to subsidise flood resistance and resilience measures; and fiscal intervention of a similar kind in respect of other adaptation issues is not beyond the bounds of possibility. Nevertheless, a scheme that involves the core tax system, or involves (spatially) widespread change, is not presently on the agenda.

Role of Regional and Local Government

Turning to the regional level, the Greater London Authority has no powers to alter tax rates, and only limited discretionary budget. However the GLA does have a precedent implementing or supporting a sustainability improvement in households, through the Home Insulation Offer in partnership with British Gas, plus contributing in-kind to the Light Bulb Amnesty. Both programmes involved innovative financial mechanisms to provide items for retrofitting and encourage pro-environmental behaviour change. Grants and/or subsidies via the London Development Agency (LDA) and communication campaigns are also strong mechanisms at the GLA's control.

At local authority level, again, the scope for manoeuvre is broader in theory than in practice. In principle, for example, local authorities could choose to vary the rate of Council Tax (but not Business Rates[8]) in order to encourage or discourage certain behaviours: lower rates could be offered for properties that use less energy, or emit less carbon, or have adapted to climate change, and higher rates could be charged for properties that use more or have not adapted.

In practice, however, such practices are extremely rare – there are innumerable possible policy objectives that could justify variations in rates and the general rule on taxes is to keep them as simple as possible. Local rates that were a bit lower if you did X, and a bit higher if you do Y and a bit lower if you do Z may soon become unworkable.

Local authorities can also, again in theory, use grant, loan or block funding in innovative ways; and there is, in this case, more established (though still rare) practice to draw upon in the real world. The London Borough of Camden, for example, has experimented with a revolving fund used to install carbon mitigation measures, in which a loan from the council to fund the new measures is paid back over a period of time [see 'larger and longer term horizon entities' above] through the savings made because of reductions in energy bills. It is conceivable that models such as this could be extended to address adaptation.

Role of Private Sector

Finally, in terms of fiscal incentives, it is important to consider the private sector. In the longer term, there is no doubt that market signals will have to do the work on adaptation: state subsidy cannot and should not last forever. In the shorter term, however, there is still room for private sector price signals to do some work, particularly if they come from entities with the kind of long time horizons we have been discussing.

Considering utilities, we will see in Chapter 3 that Thames Water, for example, already offers a modest subsidy to customers that install or adopt certain water saving measures, effectively providing a fiscal incentive. In principle, this kind of incentive could be extended along the lines outlined in Chapter 3 – if the relative cost of adaptation measures is below the cost of future alternatives, then it would make economic sense for the economy as a whole to subsidise those measures.

The second major opportunity for private sector incentives comes from the insurance sector. The insurance sector are pushing for a risk based pricing structure. By maintaining or improving a property's resilience against flood risk, the insurance premium could potentially stay lower. The incentive would be that without resilience, insurance premiums would be higher, or no insurance offered at all. The example of Florida illustrates the potential very clearly. Following the devastation of Hurricane Andrew in 1992, the Florida legislature introduced a Statute requiring insurance companies in the State to provide reductions in premiums by designated percentages, following resilience improvements to the property carried out by the property owner. The statute was updated in 2002 to ensure that homes constructed in compliance with the Florida Building Code (FBC) were automatically eligible for the insurance discounts. Independent research found that by replacing the Standard Building Code (SBC) with the FBC in 2002 reduced wind related damage to homes by between 26 and 61 per cent.

The study also found that the costs of constructing stronger houses in compliance with the FBC would be outweighed by the potential savings, including the reduction in insurance premiums due to the wind mitigation discounts (Ward et. al, 2008). In addition, it has been calculated that the construction of homes in compliance with the SBC and FBC resulted in a reduction of 60 per cent in the frequency of claims, and a 42 per cent reduction in their

[8] The pence-in-the-pound rate is specified at national level, so there is little that an individual local authority can presently do about business rates

average size, arising from Hurricane Charley in August 2004, compared with homes that were built before the codes were adopted.

This example highlights an important point of principle: that 'risk based insurance' at the household level could provide a powerful incentive to make adaptive change, in a way that would provide 'win win' outcomes. Householders would be incentivised to implement adaptation measures because they could expect lower insurance premiums; and it would be in the interests of insurers to make such reductions because they would serve to decrease the risk of future payouts. (Clearly detailed actuarial work would be required to decide upon the scale of any incentives relative to future risk-avoidance, and much further work would need to be done to establish the operational details, scope and availability of such a scheme.)

In practice, however, the regulatory environment in the UK mitigates against an option of this kind. The ABI has the ambition to ensure that flood insurance for homes in high flood risk areas are a function of the property's flood resistant and resilience properties, and the 'Revised Statement Of Principles (SoP) On The Provision Of Flood Insurance' between the Government and the insurance sector (July 2008) makes it clear that the premiums charged and policy terms will reflect the level of risk presented in higher flood risk areas. At present, however, it is difficult to say at what speed progress will be made.

It has also to be noted – crucially – that house insurance premiums in the UK are paid annually by individuals: they are not tied to the house, and do not run over multi-year periods. As per the earlier discussion on the challenge posed by the time frames over which adaptation-related decision are made, the 'insurance discount as incentive' model runs into a significant barrier – the future beneficiaries of lower insurance costs may not be the same people who received the initial incentive or made the initial capital outlay. (Suggesting, yet again, that deals of this kind might work best, in the early stages, with larger institutional residential property owners with longer time horizons.)

Dwelling further, and briefly, upon the role of the insurance sector, it was noted during the research that post-event recovery is a key time for adaptation and resilience levels to be improved within a house. This could be a mandatory or incentivised process during the post-flood damage claims assessment and repair works. The Lloyds 360 Coastal Communities and Climate Change report recommends this. Currently after a flooding incident, however, insurers only compensate for repairs to restore the property to its original standards, and the extra costs of resistance and resilience has to be borne by the home owner.

Following on from this, it may also be that there is scope for developing an accreditation scheme for loss assessors and builders that work on post-flood assessment and repair works. The meeting between a loss assessor, builder and resident is a key juncture in considering the costs and risk reduction / property values impacts that could come from improving resilience levels during the post flood repairs process, and improved awareness and skills at such a key moment could be a very effective way of introducing and/or explaining any available incentives and, by extension, of increasing the uptake of adaptation measures. The insurance sector is well placed, it would seem, to lead on the development of new practices and protocols focused on the post-flood phase.

Finally, in terms of considering private-sector-led incentives, the possibility exists of providing discounts on loans intended to fund adaptation measures. This approach is currently being considered by the Council of Mortgage Lenders, which already has a statement in favour of this practice.

Summarising, it would appear that there are several possible type of fiscal or financial incentive that could conceivably be in play; and it is clear that, having focused on a relatively narrow range of options in our detailed research, much further work could be done to flesh out the various alternative options, and to look in more depth at how they compare with one another.

Central to that comparison – and central, in fact, to any deliberation about incentives – concerns the size of the incentive relative to its impact. It may at first sight appear obvious that there will be a linear relationship: bigger incentives = bigger impacts, and vice versa. In reality, however, many other factors – current economic conditions, behavioural barriers, social norms, the length of time since the last incentive and many more – will mediate the operation of any given incentive. Sometimes, a purely nominal incentive can have a big impact because it sends a 'signal'; sometimes even large incentives can have a limited impact. Any detailed design of an incentivisation scheme ought to give very careful thought to such matters.

Regulatory incentives

There are two key techniques that warrant mention.

The first refers to ***procurement***: in general, if a client specifies a requirement, a contractor offers to meet that requirement in return for a fee. If a client specifies 'a green roof' (or, if they are more sophisticated, 'a roof with the following thermal, longevity and run-off performance…') then it is the job of a contractor to meet that requirement. If clients such as housing associations, major institutional investors and local authorities simply specify (as part of their normal refurbishment programmes, for example) that adaptation measures be incorporated, they will.

It is not quite as simple as this, obviously, as the poor progress of the government's sustainable procurement initiatives make clear[9]. Nevertheless, the generality of the principle – make change X in return for reward Y (whether that be planning permission, a contract or a discount on your bill) – is a robust one and must not be ignored simply because it is hard to implement.

Also hard to implement is the second technique, "***choice editing***". This refers to the process of eliminating 'undesirable' choices, so that decision-makers (of whatever kind) are still able to make choices, but only from a pre-determined sub-set. It is no longer possible to buy a car that runs on leaded petrol, for example; it may soon become impossible to buy a CFC light bulb; and, in principle, it would be possible to ensure that the only showerheads on the market were lo-flow models.

In practice, choice editing is a difficult and potentially troublesome task: very precise decisions need to be made, on the basis of very robust criteria; there are considerable risks of overspill or rebound; and the potential to antagonise one or more stakeholder groups is considerable. National government has certainly been very wary to date of explicit choice editing solutions, even though many in the sustainability research field argue strongly that this is a useful way forward. The obvious, and internationally proven example, would be a ranked Water Efficiency Labelling Scheme.

Other Incentives – Behaviour Change

'Softer' behaviour change techniques are increasingly being considered as a means of encouraging pro-environmental behaviour (and, indeed, other behaviour change e.g. on health and diet)[10]. It is appropriate to consider some of these techniques as 'incentives'. For example, the provision of a green concierge service (funded by the GLA/LDA) is designed to encourage householders in London to adopt greener living. For a modest fee, a variety of support and advice functions are available. The programme incentivises action

[9] As evidenced by the UK's Sustainable Development Commission, for example

[10] See Defra's "A Framework for Pro-Environmental Behaviours"

not by providing money *per se*, but by providing help and guidance to overcome 'barriers'. The Mayor's Green Procurement Code is a similar example. In both cases, the incentive takes the form of "We can make this easier for you". There is no reason, in principle, why a similar approach should not be taken with respect to adaptation.

A key theme in much behaviour change analysis (and, indeed, in projects and programmes) is the importance of group behaviour. Individuals and companies are very conscious of 'norms' and, in general, prefer to behave in the same way as 'others like me'. 'Community action' is thus important not simply because it might involve lots of people adopting a new behaviour simultaneously, but because new 'social norms' can be created that can have much wider knock on effects than simply engaging with isolated individuals.

(We see in Chapter 4, above, how the Defra pilot scheme seemed to work most successfully when community-level engagement was central to the project; and there are numerous other examples in the literature[11].)

As with many of the issues raised in this discussion section, this is not an issue upon which we have dwelt in any depth during this particular research study. But it is certainly important to bear in mind during the process of deciding 'what next?' For example, an incentive scheme focused on low-flush toilets might be better focused on a small number of geographical locations (i.e. where community engagement could be attempted) rather than on a more general London-wide programme (which might draw in a similar number of individuals but which might have fewer indirect effects).

Other Matters

To conclude our discussion, we highlight a number of other issues that have cropped up during the study:

linkages – whilst it may make sense from an analytical or policy point of view to distinguish between e.g. adaptation and mitigation, or between energy issues and water issues, at a more practical level these divisions may make less sense. For example, the most obvious manifestation at household level of reduced water use may in fact be in lower energy bills (since less water will have been heated and used in showers): in this instance, it may be that the appropriate approach to the householder is on an 'energy' footing rather than a 'water' footing. Being alert to public perceptions and practicalities (however awkward these may be from an institutional or administrative point of view) will be an important part of the next phase of this work. It will also be important to think through whether any other linkages – e.g. to the health sector – might form useful avenues for further development.

alternatives – in narrowing down from a long-list of international case studies to the two projects that were eventually fully developed for the purposes of this report, it is important to recall that the selection criteria were in large part driven by the ease with which certain data were available and the confidence with which certain kinds of cost benefit analysis could be done. It should not be presumed, therefore, that 'green roofs' have been identified as the best means of tackling (say) London's urban heat island effect or the issue of stormwater run off. It is quite possible that planting more trees (in the case of the former) or banning the hard-paving of front gardens (in the case of the latter) would be the 'best' approach at an aggregate level. Similarly the water efficiency examples assume that any barriers to delivery associated with the differences in regulatory regimes can be overcome. In choosing to move forward with pilot projects or, perhaps more pertinently, in choosing a wider strategy for the capital as a whole, these kinds of alternatives and issues will need to be fully considered.

[11] See, for example, Defra's Environmental Action Fund

technicalities – the analysis in this report has been presented at a fairly high level; yet, as we saw above when discussing insurance, in the 'real world' there is often a meeting in a damaged kitchen between a householder, a loss assessor and a builder to discuss what is actually going to happen in a real home. The retrofit sector – indeed, the retrofit idea – has tripped on numerous occasions in recent years because the technical practicalities at ground level are difficult to see from higher up. Often it is only at the point of meeting in the kitchen that it is discovered that the splendid piece of subsidised kit simply doesn't work *for this particular house*. It is important going forward, therefore, both to incorporate such technical expertise as deemed necessary at an early stage, and also to retain as much flexibility as possible in the kinds of solutions that are made available.

phasing – it is important to acknowledge that few people – whether householders or corporate – will initiate a standalone building project to tackle climate change. Much more likely is that climate change adaptation measures would be integrated into a previously intended refurbishment, upgrade or extension project. Further design of incentives, or discussion thereon, could usefully consider how best to elide with such cycles.

Finally, it is worth acknowledging that the discussion above has been made on the assumption that any and all adaptation measures will represent some sort of 'innovation' for the individuals and organisations involved. This raises three closing points:

- the relationship between innovations and how they subsequently diffuse and spread is not straightforward and could usefully be thought through;
- there will be a need for measurement and, by extension, clarity on what would count as 'success';
- there will be a need for an appropriate learning mechanism to reflect on achievements, learn from the measurements and so forth.

The London Climate Change Partnership would seem ideally positioned to address each of these.

2 PROPOSED INCENTIVE 1: GREEN ROOFS

In the light of an indicative cost-benefit analysis, which only partially accounted for a number of environmental benefits that would be associated with an increase in the number of green roofs in London, a subsidy of **~£17 per m^2** would appear reasonable. This would be justified by the quantifiable environmental benefits from installing green roofs[12] and hence the costs of the scheme will equal the benefits. A scheme for four inner city areas - Cannon Street, Oxford Street, Tottenham Court Road and Canary Wharf – with a green roof area of 226,750m^2 would cost around £4 million and provide environmental benefits[13] worth £4 million. A wider scheme covering the City of London, part of the London Borough of Hackney, part of the London Borough of Tower Hamlets and part of the West End with a green roof area of 3.2 million m^2 would cost around £55.5 million and provide environmental benefits worth £55.5 million. A potential green roof grant could also be incorporated into a wider homes retrofit programme to improve energy and water efficiency in existing domestic stock.

It would also be reasonable for the GLA to coordinate, and at least part fund green roof grants given its remit. It would be worth examining whether the incentive scheme should be based on grants or loans, similar to those used by the London Climate Change Agency for mitigation measures. Funding could possibly be jointly administered with councils with the greatest potential to benefit from green roofs. Given the benefits of storm water management and energy saving, utility companies could also be involved in funding a green roof programme.

2.1 Introduction

Buildings gain heat from many sources including lighting, electrical equipment, building occupants and the sun. In urban areas, such as London, buildings soak up this heat during the day and emit it at night, causing and exacerbating the Urban Heat Island (UHI) effect. For the building fabric, the main heat gain sources are: windows, external walls and roofs, internal electrical/electronic equipment and external air temperature. As the mean outside temperature rises, it will become harder to cool buildings by natural ventilation. London's UHI will worsen with increases to average and extreme temperatures. This requires other ways to cool our homes rather than relying on energy-intensive air-conditioning. Air-conditioning also generates waste heat which is dumped into the urban environment.

The '*Your Home in a Changing Climate'* report identified a number of passive adaptation measures for enhancing natural ventilation and reducing solar gain. Measures such as reflecting blinds, awnings, better roof insulation, reflecting exterior paints and insulation are all cost-effective ways to reduce overheating. There are a number of other ways to reduce the UHI effect such as green roofs and walls, reflection roofs, tree planting, not paving over front gardens, removing hard surfaces and replacing them with plants.

Some of these measures are also helpful in reducing surface water run-off and can be effective measures for storm water management. Flood risk in London is already significant because of extensive population and homes in floodplain areas.

This chapter specifically looks at the option of using green roofs to adapt to climate change impacts – hotter temperatures and surface water flood risk. This is because the only case

[12] The main public environmental benefits not quantified are public health, aesthetic and biodiversity benefits.

[13] Stormwater management, Combined Sewer Overflow, Air Quality, Urban Heat Island, Greenhouse Gases and Food Production.

studies identified of economic incentives to reduce over heating related to grants for green roofs.

2.1.1 International experience with financial incentives for green roofs

Internationally, Germany has had some form of green roof policy for the best of 30 years. A survey by the FBB (Fachvereinigung Bauwerksbegrünung e.V), the main green roof association in Germany, in 2004 found that 18% of municipalities with a population of over 10,000 offered direct financial aid, 50% offered stormwater fee discounts and 36% had green roof requirements as part of their local development plans. Direct financial subsidy was around 10-20 €/m² (7 – 14 £/m^2) of green area, which covered around 25% to 50% of the additional costs of green roofs. The annual stormwater fee discount for green roofs was between 50 and 100%. Initially, direct financial incentives were introduced in Germany as green roofs were expensive and the market was undeveloped. Over time, as the markets became more competitive, direct financial incentives were either reduced or withdrawn. Currently around 80% of German cities with a population over 100,000 have stormwater fee discounts compared to only 5% of cities with direct financial subsidies.

Cities in North America and Basel in Switzerland have also introduced financial incentives for green roofs. More recently, New York City passed a law in June 2008 which will allow building owners in New York City who install green roofs to receive a significant tax credit. Under this law, building owners in New York City who install green roofs on at least 50 percent of available rooftop space can apply for a one-year property tax credit of up to $100,000. The credit would be equal to $48 per square metre of roof area that is planted with vegetation, or approximately 25 percent of the typical costs associated with the materials, labour, installation and design of the green roof. This legislation has been influenced by Storm Water Infrastructure Matters, a coalition of more than 50 green building and community organizations in the New York area dedicated to ensuring fishable and swimmable waters around New York through natural, sustainable storm water management practices.

See Table 2.1 for a summary of these and other cities' financial incentives. A detailed case study of the Toronto Green Roof Programme is given in the Annex.

Table 2.1: Examples of Cities with Financial Incentives for Green Roofs

Direct financial incentives	
Munich, Germany	Greened retrofitted roofs qualify for a subsidy of 30 €/m² (22 £/m^2) to a maximum of 50% of the cost.
Stuttgart, Germany	€51,000 (£37,900) available a year, pays for 50% of the costs, or up to a maximum of 17.90 €/m² (13.3 £/m^2)
Basel, Switzerland	First phase 1996-1998: SFR 1 million (£555,000)[14], 20 SFR/m^2 (11 £/m^2) Second phase 2005-2007: SFR 1.5 million (£664,000), 30-40 SFR/m^2 (13-18 £/m^2)
Montreal, Quebec, Canada	54 CAN$/m^2 (27 £/m^2)
Bremen, Germany	The city state of Bremen subsidizes 25% of the costs of roof greening to a maximum of €1,500 (£1,100)
North-Rhine Westphalia, Germany	Four types of subsidy for stormwater management: 1. Removal of impervious surfaces - 15 €/m^2 (11 £/m^2) of removed surface

[14] -January 03,1996 1SFR= 0.555324 GBP; January 02, 2006 1SFR= 0.442502 GBP Hhttp://www.x-rates.com/cgi-bin/hlookup.cgiH

	2. Infiltration systems - €15/m^2 (11 £/m^2) of infiltration surface 3. Green roofs: €15/m^2 (11 £/m^2) 4. Systems that re-use rainwater: up to €1,500 (£1,100) per system
Chicago, US	100 US$/m^2 (69 £/m^2)
New York, US	48 US$/m^2 (32 £/m^2)
Indirect financial incentives	
Münster, Germany	Stormwater fee is reduced by 80% from 0.44€/m^2/year (0.32 £/m^2/year) to 0.09 €/m^2/year (0.07 £/m^2/year) A green roof with very high retention is charged 0.09€/m^2/year
Oregon, Portland, US	Stormwater fee is reduced by 35% for installing green roofs with at least 70% of the roof area covered. In 2006, the stormwater management charge for single-family residence was US$13.30 (£9.2) per month

2.1.2 *Risks and impacts of overheating*

Climate change will cause average summer temperatures to rise to a point where our current 'extreme events' will be average summer temperatures by the middle of the century, and heat waves will be even hotter. Summer temperatures for the South East of England are projected to be up to 3.5°C warmer by the 2050s and up to 5°C warmer by the 2080s[15] . London's existing housing stock has not been specifically designed for the hotter summer temperatures projected over their lifetime.

Main impacts

- Overheating can be directly responsible for deaths when the night time temperatures do not drop sufficiently to allow people to cool down and recover, and when temperatures remain high for several days in a row. In August 2003, an estimated 2,000 additional premature deaths occurred in the UK as a result of heat stress over the two-week period of the heatwave, with 600 of these deaths occurring in London alone.
- Overheating can cause discomfort and lead to lack of sleep and loss of productivity and alertness.
- Heatwaves increase demand for water through increased bathing and discretionary use of water.
- Increased use of air-conditioning would lead to higher energy use and thus high CO_2 emissions.
- High temperatures may reduce the potential rent and sales valuations of London's property, through the buildings being less fit for purpose than better adapted buildings.

2.1.3 *Green roofs as a measure to reduce overheating*

Green roofs have been identified as a very effective measure for making buildings more thermally efficient and contributing towards reducing the UHI effect. The broader environmental benefits of green roofs, such as reducing surface water run-off, reducing air pollution and noise and providing green space for people and wildlife are well-tested and

[15] UKCIP02 climate change scenarios, UKCIP.

becoming better known. Green roofs also have direct economic benefits such as prolonging the life of the roof and reducing energy costs[16]. In addition, the vegetation that green roofs provide within an otherwise grey urban setting may have psychological benefits for people who look at them. All this suggests that green roofs have the potential to play a significant part in improving the quality of urban life and adapting to climate change.

With environmental problems requiring urgent attention, a number of countries in the world have become interested in green roof technology. Germany is recognised as a world leader in green roof technology, from both a theoretical and a practical standpoint. Cities in North America, Switzerland and Japan currently have policies and incentives to promote green roofs.

2.2 Recommendation for London

Green roofs can be used to reduce the UHI effect in central London and also help against the risk of surface water flooding. The economic case would have to be bolstered by incentives where benefits can be maximised and costs minimised to ensure they generate net economic benefits. There are already many examples of green roofs in London including at Canary Wharf, Bishops Square, the Laban Centre, Deptford and Offord Street, Islington.

The overall benefits of green roofs in London may be relatively restricted due to:

- the abundance of green space in the centre of the city;
- the limited number of households in the very built up areas of London where green space is lacking; and
- the limited availability of flat roofs appropriate for green roofs.

A London-specific scheme should consider the following recommendations:

- A pilot incentive scheme should be preceded by a study building on the London Living Roofs report and outlining the details of the eligibility criteria as described above.
- The pilot scheme should estimate the area of warm roof and inverted roof in highly built-up parts of London as installing green roofs on inverted roofs is more cost effective compared to warm roofs.
- A London specific study is required to quantify the environmental benefits of stormwater retention and the energy savings as these are among the easier benefits to quantify.
- An indicative cost-benefit analysis, which only partially accounted for a number of environmental benefits, would suggest a subsidy of ~£17 per m^2 being justified by the quantifiable environmental benefits from installing green roofs.
    - A scheme for four inner city areas - Cannon Street, Oxford Street, Tottenham Court Road and Canary Wharf – with a green roof area of 226,750m^2 would cost around £4 million and provide environmental benefits[17] worth £4 million.
    - A wider scheme covering the City of London, part of the London Borough of Hackney, part of the London Borough of Tower Hamlets and part of the

[16] GLA Living Roofs Report (2008)

[17] Stormwater management, Combined Sewer Overflow, Air Quality, Urban Heat Island, Greenhouse Gases and Food Production.

West End with a green roof area of 3.2 million m^2 would cost around £55.5 million and provide environmental benefits worth £55.5 million.

- Since a number of environmental benefits are identifiable but not quantifiable, there is a case for providing increased financial incentives to increase uptake of green roofs, but it is not possible to estimate this.
- Supplier incentives, such as tax breaks, should also be considered to reduce the capital costs of green roofs, which are currently very high in London relative to other cities in Europe and North America.
- The forum of key stakeholders in London responsible for developing an 'Urban Greening Programme' should review and endorse the non-monetised environmental benefits of green roofs. This would add weight to any policy decision for an incentive scheme where retrofitted green roofs are not cost-beneficial on paper.
- Most of the financial incentives currently in place in other parts of the world were not calculated using cost-benefit analysis. They were either based on equity considerations for spending an allocated pot of money or cover around 25-50% of the additional costs of green roofs.

The basis for these recommendations is developed in the following section.

2.3 Quantification and Justification for a London Green Roof Incentive Scheme

A green roof incentive scheme in London can be designed for households and/or commercial organisations. An incentive scheme will depend on a number of factors ranging from type of scheme to cost-benefits of green roofs, type of building and characteristics of the built-up area.

2.3.1 Eligibility criteria for any scheme

1. Eligible applicants could include:

   - Home or property owners
   - Tenants with the approval of landlords.
   - Housing associations or other legal entities
   - Business owners (including legal entities)
   - Any priority groups

2. Areas eligible for funding:

   - Green roofs should be targeted mainly in areas of a city, lacking in green space, particularly those areas with high building density. In London, it has been estimated that 24,000 hectares of buildings (and therefore roofs) cover Greater London. This is equivalent to 16 per cent of the surface area of the capital, an area 16 times the size of Richmond Park. In London, flat roof space is not very common, and even in the centre there is a mix of roof types (warm roof or inverted roof). According to the London Living Roofs study, for four areas (Cannon Street, Oxford Street, Tottenham Court Road and Canary Wharf) of Central London selected, it was estimated that an average of 32 per cent of roof area potentially could be greened[18].

[18] Living Roofs, 2008

3. Green roof measures eligible for funding for retrofitting:

- Minimum guidelines for share of roof footprint and slope of the roof (even in the centre of London there is a mix of roof types)
- Height of system (determines environmental benefit – a minimum depth of 100mm is required to deliver any significant environmental benefits)
- Mix of vegetation and growing medium
- Type of green roofs
    - Intensive green roofs – these are principally designed to provide amenity use and are normally accessible for recreational use. They may be referred to as roof gardens or terraces.
    - Extensive green roofs – generally provide greater biodiversity (substrate based) interest than intensive roofs, but are considered to be less appropriate in providing amenity and recreation benefits. In the UK extensive green roofs are either mat or substrate-based systems.
    - Recreational roofs – these are designed specifically for recreation and have limited SUDS (sustainable urban drainage systems) or climate change adaptation benefit, (except cool roofs – see below) and no biodiversity value.

Table 2.2: Potential Environmental Benefit from Different Types of Green Roofs

Roof Type	Potential Benefit					
	Climate Change	Building Energy Balance	UHIE	SUDS	Biodiversity	Amenity
Intensive	++	++	+++	+++	+	+++ (visual)
Extensive - mat based <40mm	+	+	+	+	+	+ (visual)
Extensive - substrate based <75mm	++	++	++	++	+++	+ (visual)
Recreation	+*	+*	no	no	no	+++ (sports/ play)
* These advantages are only realised on recreational roofs if vegetation introduced in the form of planters and cool roof technology , are also utilised						

Note: UHIE – Urban heat island effect, SUDS – sustainable urban drainage systems
Source: GLA Living Roofs 92008

4. Conditions for funding:

- Any systems constructed for the management or reuse of rainwater must be technically sound and meet the required standards.
- The building should be capable of supporting a green roof that meets certain specifications and requirements, e.g. minimum runoff coefficients (usually ≤ 0.3), height of substrate, slope of roof and type of vegetation.
- Evidence to show property owner commitment for maintaining the subsidised green roof for at least 10 years after its installation.
- Measures must not conflict with building regulations, building codes or with the laws for the protection of historical buildings.

- Proof that financial resources, in addition to the grant or other incentive, are available for the proposed green roof.
- Subsidy will only be given post-installation.

5. Amount of financial incentive. This can be determined in two ways, either:

- £x per square metre of green roof area or,
- by calculating the percentage of costs of construction or construction and design, frequently between 10 and 50% is covered.

Most programmes have a maximum limit for each applicant. In addition to financial support, these programmes may also provide design and technical advice.

2.3.2 Quantifying costs and benefits of green roofs

Studies on cost-benefits of green roofs are scare. In the literature, there is considerable variation in the estimated benefit-cost ratios and life-cycle costs between green roofs and standard roofs. Any comparison of green roofs with standard roofs should be made using a whole-life costing analysis, to demonstrate the long-term benefits of an initial capital cost. Green roofs in general last twice as long as standard roofs as shown in Table 2.3 below.

Table 2.3 Lifespan of Roofs (years)

Type of roof	Singly ply	Bitumastic	Aluminium
Bare Roof (standard)	25	30-35	25
With Green Roof	50	60-70	50

Source: Living Roofs, GLA 2008

The cost of a green roof will vary depending on the system used. It will also depend on the height of the building, number of intrusions, size and type of system, depth of insulation required and many other factors. Indicative costs of green roofs are given in Table 2.4 below.

Table 2.4: Indicative Costs for Green Roofs

Type of roof (Installed)	£ per m^2	Source
Warm roof (non green roof)	55	Living roofs, GLA (2008)
Warm roof (sedum blanket)	110	Living roofs, GLA (2008)
Inverted – external insulation (shingle)	60	Living roofs, GLA (2008)
Inverted - external insulation (paving)	70	Living roofs, GLA (2008)
Inverted (Substrate based green roof systems without additional substrate)	110	Living roofs, GLA (2008)
Green roofs	63 - 158	Acks (2003)
Green roofs (over and above standard roofs)	44 -53	Toronto (2005)
Extensive Green roofs (over and above standard roofs)	12.5 - 24	Current estimates in Germany
Maintenance costs (per year)		
Standard roofs	0.6	Acks (2003)
Green roofs	3.8	Acks (2003)

Note: Warm roof – a roof with a conventional roofing surface is called a warm roof as it absorbs sunlight and heats-up quickly. Substrate based systems are generally between 75mm and 150mm in depth, consisting of either a porous substrate or similar reused aggregates. Sedums are a type of plant with water-storing leaves. Many Sedums are cultivated as garden plants, due to their interesting and attractive appearance and hardiness.

Green roofs cannot be valued accurately on financial aspects alone. Currently, some benefits can be quantified and translated into cost savings while others can be quantified but not easily assigned a monetary value and still others are very difficult to quantify. Moreover, costs-benefits are affected by site-specific characteristics and factors peculiar to any one project. A green roof over a warehouse will have different impacts to one on a residential or office building. Green roofs are most cost-effective on an inverted roof compared to a warm roof, as the structural capacity to hold a green roof substrate-based system is already present. The additional cost of a green roof on an inverted roof is only 50% more than a normal roof. A warm roof is likely to be at least double the cost of a normal roof.

Green roofs are particularly cost effective when a roof is due for replacement. Currently, green roofs cost around (£14-21 per m^2)[19] in Germany and Switzerland. In the US green roofs are often 5-10 times more expensive, which reduces their cost-effectiveness.

For the reasons above, costs and benefits in this report are mainly indicative in nature. Table 2.5 below outlines the main costs and benefits of green roofs that can be quantified.

Table 2.5: Quantifying Costs and Benefits of Green Roofs

Private Benefits		**Public Benefits**	
Increased service life for roof membrane	+++	Reduced storm water runoff expenditures	+++
Reduced energy use for cooling	+++	Reduced urban heat island	++
Sound insulation	+	Improved air quality	++
Food production	+++	Reduced greenhouse gas emissions	++
Aesthetic value	+	Improved public health	+
		Aesthetic/Biodiversity value	+
Private Costs		**Public Costs**	
Additional installation cost of green roof	+++	Programme administration and setup	+++
Maintenance costs	+++		

+++	Quantifiable and translated into monetary value
++	Quantifiable but difficult to translate into monetary value
+	Difficult to quantify

Stormwater retention and energy savings are among the easier benefits to quantify. Benefits such as the well-being of building occupants or the improved aesthetics of green roofs cannot be quantified. A number of other environmental benefits difficult to quantify are:

- Protecting the roof from ultraviolet radiation
- option of cleaning and recycling grey water
- absorption of electromagnetic radiation
- use of recycled materials
- Ecology & Biodiversity
    - provision of quiet refuges
    - providing links or stepping stones in greenspace networks

[19] January 02, 2009 1 $UD= 0.693062 GBP Hhttp://www.x-rates.com/cgi-bin/hlookup.cgiH

- often only available green space in inner urban core
- Amenity
  - more options for designers
  - hides grey and uniform roofing materials
  - screens equipment
  - attractive views of vegetation
  - extension of park system
  - provides gardens - more people space
- Health
  - psychological benefits of contact with nature
  - improved water quality
- Building Fabric
  - Protecting the roof from mechanical damage
  - reducing diurnal/seasonal temperature changes in roof

There is a risk that benefits whose monetary value is difficult or impossible to determine are considered valueless. Please see detailed case study on the Toronto Green Roof programme in the Annex for cost-benefit estimates of green roofs.

2.3.3 Cost and Benefits of Green Roofs for London

In order to calculate Whole Life Costing (WLC), the GLA Living Roofs study calculated the Net Present Values (NPV)[20] of a number of green roof types based on a base data for a typical green roof (Table 2.6 below).

Table 2.6: Base Date for the NPV Analysis

Roof size	850m^2
Insulation 'U' value	0.25
Cost of energy (average)	17p/kWh
Discount Rate[21]	8%
Green roof life	33 years

Source: GLA Living Roofs

The NPV calculations modelled the costs of green roofs against only the benefits from energy reduction and extended life of the roof. All the NPVs were negative since there was no direct income or benefits (apart from energy reduction) to offset the cost. The lowest NPV in this kind of cost-effectiveness analysis is always the preferred option when wider benefits are not quantifiable.

GHK has calculated some of the other environmental benefits using estimates from the Ryerson University Study for the City of Toronto[22] (Table 2.7 below). The present value of these additional environmental benefits was adjusted according to the base data used in the Living Roofs study. The additional environmental benefits reduce the NPV but since

[20] Form of Whole Life Costs analysis.

[21] This discount rate is not consistent with the HMT Green Book rate of 3.5%, but due to the lack of access to the base data, it was not possible to recalculate NPVs. However the different rate should not provide significant differences given the overall indicative nature of the numbers.

[22] See Toronto Green Roof programme case study in the Annex.

they are still negative, imply that retrofitted green roofs are not cost effective. According, to our calculations a subsidy of around £17per sq. metre would be justified by the quantifiable environmental benefits (in NPVs) of green roofs. This amount is similar to the green roofs scheme in Stuttgart and Basel but lesser than the scheme in Montreal, Chicago and New York (from Table 2.1). Given that a number of environmental benefits, as described in section 3.2.2, are not quantifiable a further mark up of, say 20%-30%, would increase the value of the subsidy. However, the size of the mark up would be an arbitrary amount and not an informed judgement. Moreover, most of the unquantifiable benefits are private benefits which would not justify any form of public subsidy.

Table 2.7: NPV of Green Roofs Adjusted for Environmental Benefits

Whole life cost and benefit	**Average of extensive substrate based green roof (on inverted roofs) £s**	**Source**
Total capital costs	86,594	GLA Living Roofs study
Total maintenance savings	2,763	
Total energy savings	27,625	
NPV	**-64,387**	
Environmental Benefits		
Stormwater Management	1,076	Toronto (2005)
Combined Sewer Overflow (CSO)	627	
Air Quality	673	
Urban Heat Island	4,045	
Greenhouse Gases	238	
Food Production	8,078	Acks (2003)
Total Environmental Benefits	14,736	
Adjusted NPV	**-49,651**	

Note: The Living Roofs study used NPV for WLC for comparing a number of green roof options (see Appendix 3, pg.55).

The financial incentive of £17 per sq. metre is based on a number of assumptions and caveats:

- The incentive figure is based on an indicative cost-benefit estimate of green roofs.
- The estimates for environmental benefits are not specific to London.
- Costs and benefits of green roofs differ by type of building, purpose, site location and type of green roof.
- A number of other benefits, such as noise reduction, aesthetic benefits, biodiversity benefits and psychological and health benefits (which may manifest themselves in improved property values) have not been included.
- Reduction in the UHI effect is a function of concentration of green roofs and availability of other forms of green spaces, which are already abundant in London.

2.3.4 *Funding a Green Roof Incentive Programme*

A Green Roof Incentive programme can be considered for the four inner city areas in Central London with limited green space and four larger sample areas, as given in the Living Roofs study. The environmental benefits as calculated in Table 2.7 and overall size of the scheme assuming a financial incentive of £17 per sq. metre for the two areas is given in Table 2.8 below. Since, we have set the subsidy equal to the environmental benefits means that the NPV of environmental benefits and the size of the scheme are the same.

Table 2.8: Total Environmental Benefits and Size of Scheme

Area	**Potential roof area that could be greened (m^2)**	**NPV of Environmental benefits**	**Size of scheme**
Four inner city areas - Cannon Street, Oxford Street, Tottenham Court Road and Canary Wharf	226,750	£4 million	£4 million
Four larger sample areas - City of London, part of the London Borough of Hackney, part of the London Borough of Tower Hamlets and part of the West End.	3.2 million	£55.5 million	£55.5 million

It would also be reasonable for the GLA to at least part fund green roof grants given its remit. Potential funding streams include:

- The innovation and opportunity fund element of the 2008-11 regional housing fund; and
- The JESSICA (Joint European Support for Sustainable Investment in City Areas)EC funding secured by the LDA (2007-13).

It would be worth examining whether the incentive scheme should be based on grants or loans, similar to those used by the London Climate Change Agency for mitigation measures. Funding could possibly be jointly administered with councils with the greatest potential to benefit from green roofs. Given the benefits of storm water management and energy saving, utility companies should also be involved for funding a green roof incentive programme.

The Toronto case study and scoping of a potential green roof scheme for London have highlighted a number of key issues:

- Retrofitting green roofs is more difficult and complicated than new build.
- There are economies of scale with green roofs, i.e. it is more cost-effective to install a green roof on a building with a larger roof area compared to a building with a smaller roof area.
- Green roofs require significant maintenance commitment from households and/or developers.

- There are competing cost-effective ways to reduce the UHI effect and storm water run-off, such as green walls, reflection roofs, tree planting, not paving over front gardens and removing hard surfaces and replacing them with plants.
- The costs-benefits of providing incentives to households should be compared to targeting businesses and local councils (who generally own/manage larger areas of green spaces). Public money could be better used by incentivising the placement of green roofs on larger buildings rather than domestic housing, or getting local councils to manage public/ green space to counter urban heat island effects.

List of Interviewees:

Brad Bamfield, Managing Director, The Solution Organisation

Dusty Gedge, President European Federation of Green Roof Associations

Wolfgang Ansel, Director, The International Green Roof Congress

Bill Watts, Senior Partner, Max Fordham Consulting Engineers

Dr. Stephan Brenneisen, Life Sciences & Facility Management, Zurich University of Applied Sciences

Ilze Andzans, Sr. Environmental Specialist, Toronto Water

3 PROPOSED INCENTIVE 2: WATER EFFICIENCY - TOILETS AND SHOWER HEADS

On the basis of a detailed cost-benefit analysis, and information and assumptions on London water fittings, a five year programme could be proposed offering:

1. A subsidy of £44 to any consumer choosing to buy a water efficient toilet (e.g. single-flush 4.5 litre siphon toilet), could potentially increase the penetration of such toilets from 2% in 2009 to 9% of total toilet purchases in 2013, with potential savings of 9,200 ML over the expected lifetime of the product (16.5 years). This equates to 557ML on average saved each year. The value of the subsidy of such a scheme would be £6.5 million (£8 million including administration costs) over 5 years providing a subsidy for 148,000 toilets.

2. A 100% subsidy of £10 each to any consumer choosing to buy an water efficiency showerhead could potentially increase the penetration of such showerheads to 80% of total replacement showerhead purchases in 2013, with potential savings of 67,000 ML over the next 10 years. This equates to a potential 6,700 ML on average each year. The incentive estimates a relatively ambitious take-up of showerheads as they would be free at the point of sale compared to the low efficiency alternatives. The cost of the subsidy of such a scheme would be £9 million over 5 years provide rebates for 916,000 showerheads. Over a 5 year period this could also save 202,500 tonnes of carbon (on average 40.5t / yr) due to the energy savings associated with reduced use of hot water saving customers approximately £41 per year.

The sectors and organisations that have a potential role to play in funding and/or implementing these proposed schemes, include water and energy utilities, existing low-carbon schemes, plus central, regional and local government levels. The water companies would benefit through reducing their costs of supply, as part of their water efficiency targets and own corporate objectives. The energy companies would benefit in securing customer base and achieving CERT targets. Government levels would benefit from reporting reductions in carbon emissions related to hot water use within their area.

Funds for both toilet and showerhead subsidies, could also be considered for incorporating into a wider pan-London homes retrofit programme, to improve energy and water efficiency in London's existing domestic stock.

3.1 Introduction

Cities around the world are experiencing water shortages attributed to an increase in demand and a reduction in supply from precipitation and groundwater sources. Long-term water resource planning is particularly important for London, due to:

- London's per capita consumption has reduced slightly from 2006- to 2008, however changes in long-term domestic behaviour have resulted in higher demand per person. Combined figures for London's water suppliers show that average per capita user per day increased from 153 litres in 1990 to an average of 161 litres from 2003/04 to 2007/08;
- Reduction in household size as on average each person in a small household uses more. Ie. More water using items per person;
- Increasing population;
- Increasing use of higher flow showers;

- Climate change – hotter summers are predicted leading to higher usage coupled with the increasing frequency and intensity of droughts.

UKCIP02 projections show total annual precipitation decreasing over time. Both reduced summertime precipitation and greater evaporation of surface moisture caused by hotter temperatures will result in lower water availability in summer.

If the long-term water demand and loss outstrips water availability, responses could include imposing restrictions (eg. hosepipe and sprinkler bans as per summer 2006) and/or increasing supply infrastructure capacity.

3.1.1 *Measures to increase water efficiency*

Much work is being done to reduce water losses in London's aging distribution system. However, with the majority of water usage allocated to the domestic environment, the greatest opportunity to improve demand management is to be found through improving the water use devices and behaviours in London's existing housing stock. As part of this process, water companies and regulators are currently expanding the use of water meters, increasing education and awareness campaigns and on a small scale, increasing uptake of water saving devices.

A feasibility study[23] on 'Water Neutrality for the Thames Gateway' suggested that retrofitting existing homes in the Thames Gateway with water-saving appliances could potentially save between 23%-47% of the water required to maintain consumption at current levels while accommodating planned new developments.

Devices such as water-efficient showers also provide energy/carbon and financial savings. A case study in the '*Your home in a changing climate report*' estimated that a water efficient shower retrofitted into a large family home could save 40,880L per year, energy savings of 1,430 kWh, carbon savings of 600kg CO_2 and financial saving of around £132 per year. An Environment Agency briefing note[24] states that when household and water company emissions are considered together, then 89% of emissions in the water system can be attributed to 'water in the home'. This includes energy for heating water but excludes space/central heating.

Cities around the world have initiated programmes to increase uptake of water saving devices to cope with increase water demand or postpone/avoid expensive infrastructure investments. See annex for case studies of cities with financial incentive programmes, such as rebates and discounts to increase uptake of water saving devices. These provide a key basis for the recommendations for London.

3.2 Recommendations for London

A London-specific programme to subsidise the retrofitting of toilets and showerheads should consider the following recommendations:

- A subsidy of £44 per toilet could be provided for householders over a five year period, to stimulate an increase in the market for efficient 4.5L single flush siphon toilets (4.5l) in London from 2% in 2009 to 9% in 2013. The toilet retrofit programme should be marketed, with appropriate publicity, to those homeowners and landlords wishing to replace an end of life toilet. The toilet retrofit programme would require a minimum budget of £8 million (in London), including marketing and administration costs, to achieve a potential water saving of 300,000 m^3 per annum.

[23] http://publications.environment-agency.gov.uk/pdf/SCHO1107BNMC-e-e.pdf?lang=_e

[24] Hhttp://publications.environment-agency.gov.uk/pdf/GEHO0508BOBS-E-E.pdfH

- The provision of a subsidy of £10 per showerhead to consumers to increase the proportion of showers with efficient showerheads from 10% in 2009 to 80% in 2015. A showerhead retrofit offer would require a budget of £8 million, including marketing an administration costs, to achieve a water savings of $67m^3$ over 10 years The showerhead retrofit programme should be marketed to all homeowners and tenants, with a mixer shower system installed in their property. The subsidy should be offered for a period of 5 years to reflect the average lifespan of a showerhead in London

- Any specific subsidy or incentive could also be incorporated as part of any large-scale or pan-London retrofitting programme, with either low-carbon or sustainable housing improvement being the programme driver. The improvements in water efficiency will have deliver carbon and household bill reductions for energy and water (if metered).

- Delivering water efficiency through Carbon Emissions Reductions Target (CERT) commitments should be investigated by London's energy suppliers. Incentives/subsidies for water efficient showerheads could be used to help achieve CERT commitments within London's existing housing stock.

3.3 Quantification and Justification for a London Scheme for Water Efficient Toilets and Shower Heads

3.3.1 Introduction

In London, four water companies - Thames Water; Essex and Suffolk Water; Sutton and East Surrey Water and Three Valleys Water – supply households and businesses with water. Their water strategies include:

- Increasing levels of household metering
- Encouraging customers to save water i.e. domestic leak detection and repair schemes, some water efficient products and promotions.
- Developing new sources of water

In 2004, the average London resident used 165L of water per day[25]; around one-third of which was used for toilet flushing. This was a 7% increase over 1992 per capita water consumption. Changes in appliance ownership patterns and average household size have both contributed to this increase. In order for London to maintain a sustainable water supply in the face of population growth and climate change, plus to works towards the Government's aspiration target of 130L/person/day, per capita water consumption will need to fall.

3.3.2 Designing a Subsidy Scheme for London – Water Efficient Toilets

Nature of the Subsidy

The case study cities' programmes were designed to promote the replacement of older inefficient toilets installed in households with more efficient products, mainly for reasons of water efficiency. However a subsidy programme aimed at properties where replacement is already planned (for example, for aesthetic or end-of life reasons) could still capture a sizeable proportion of the market.

Since 2001, the Water Supply (Water Fittings) Regulations (1999) have mandated a 6l maximum flush volume for single and dual flush toilets sold in the UK. Additionally, the secondary flush option on dual flush toilets may not exceed 2/3 of the maximum flush volume.

In the UK around 2.6 million toilets are sold annually (2008),[26] of which 400,000 are sold in London. This level of sales is anticipated to remain relatively constant for the next 10 years.

Table 3.4: Projected annual sales of toilets in London[27]

Flush Volume	2009	2011	2016	2021
6l	27,040	27,700	14,800	-
6/4l	304,200	301,600	302,500	327,600
4.5l	6,760	17,300	48,000	54,600
Total	**338,000**	**347,000**	**365,000**	**382,000**

Source: Actions to improve water closet design and efficiency, UK Market Transformation Programme (2008).

As shown in Table 3.4 above, the 6/4l dual flush toilet is currently the most popular model in London. Product specifications for the 6/4l toilet state an average of 4.5l per flush, but in

[25] Source: Audit Commission community profiles (2008)

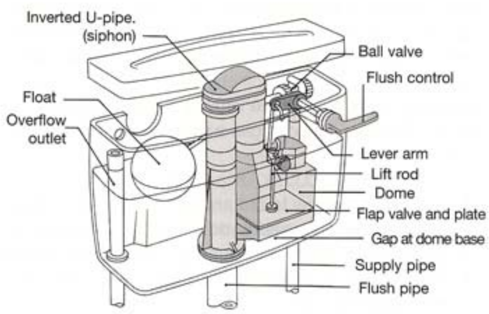
[26] Source: Market Transformation Programme (2003) Actions to improve water closet design and efficiency

[27] These do not include 6/3 or 4/2.7 litre toilets which are as yet to be on the market so are difficult to project in terms of sales.

reality, they have been found to consume from 6.1l[28] to 8l per flush[29]. This is due to a lower ratio of full to half flushes and a higher flush volume when units are connected at standard household water pressure. Moreover, around 7%[30] of all dual flush toilets suffer from leaks due to improper installation and/or wear and tear. A leak of up to 2.5L per hour will not be easily detectable, but will accumulate to over 22m^3 per year or 363m^3 over the lifetime of the unit[31].

The average toilet in the UK uses around 9L per flush, therefore any replacement model will result in water savings. However, these savings would be maximised if consumers purchased the most efficient toilet. Siphon Single Flush Toilet systems (Figure 4.1a) tend to be more efficient than the valve flush toilet systems (Figure 4.1b). A 6l single flush (or improperly used 6/4 dual flush) toilet will use 26.3 m^3 of water over its lifetime, 7m^3 more than a 4.5L single flush siphon toilet.

Figure 4.1a Siphon Toilet (4.5l)



Source: http://www.diynot.com/forums/viewtopic.php?t=90119

A London toilet subsidy programme could aim to shift the toilet sales towards the most efficient 4.5Lsingle flush models, rather than less efficient 6L and 6/4L models. In order to model this, we have considered a scenario for potentially shifting 5% sales of inefficient toilets (6L and 6/4L) to the more efficient 4.5L toilets per annum for a 5 year period, starting in 2009.

Value of the Subsidy

In London, the cost of supplying residential customers with water and wastewater services is significantly higher than in the case study cities (Table 3.5) but generally lower than other water companies in England[32]. Currently, London's water suppliers charge approximately £0.99 per m^3 on average for household water consumption and £0.49 per m^3 for sewage disposal. This equates to average household water bills ranging from £263 - £283 per year.

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[28] Source: Market Transformation Programme (2008) Water closets – water efficiency performance tests

[29] Identiflow® Monitoring of New Properties, WRc Ref: UC7129, May 2006. Creasey and Bujnowicz

[30] BN DW WC: Actions to improve water closet design and efficiency - Briefing Note relating to Policy scenario objectives in Policy Brief Hwww.mtprog.com

[31] Source: Environment Agency (2008) The economics of water efficient products in the household

[32] Ofwat, sp compare to South West Water whose charges are highest by far in the country

Table 3.5: Case study cities' water and sewer rates[33]

City/State	Year	Water Charge £/m^3	Sewer Charge £/m^3	Combined £/m^3
London	2007/08	0.99	0.49	1.48
Sydney (Australia)	2007/08	0.81	NA	0.81
Calgary (Canada)	2001	0.72	0.45	1.17
Austin (USA)	2008	-	-	0.39
York Region (Canada)	2004	0.29	NA	0.29
Queensland (Australia)	2008/09	0.28	NA	0.28

Note: London's price based only on fees charged by Thames Water

Thames Water: http://www.thameswater.co.uk/cps/rde/xbcr/SID-BB4AFD39-EFAC2CCB/corp/200708-metered-charges-leaflet.pdf
Sydney Water: Service charges 2007-2008
City of Calgary: Water Meter Incentive Program: Sign-up and Save!
City of Austin: http://www.ci.austin.tx.us/water/rateswr08.htm
York Region: Water for tomorrow promotional material
Queensland: Water Advice fact sheet: Residential water and sewerage charges

Encouraging the installation of higher efficiency toilets would reduce household water bills on metered properties.

In order to shift 5% of sales from inefficient toilets (6L and 6/4L) to the 4.5L toilets or increase the market share of 4.5L toilet, from 2% in 2009 to 9% in 2013, the programme would need to provide around 148,000 rebates. Approximately 65,500 of these would be a deadweight loss to the programme (consumers who would have purchased the efficient toilet without a subsidy[34]). Such a deadweight loss is inevitable as part of a subsidy programme, which although it substantially increases levels of purchase also subsidisies those who would have purchased the item anyway.. The programme would be the equivalent to reducing the number of consumers purchasing in-efficient toilets (6L and 6/4L) by 5% annually over five years

Table 3.6: Impact of subsidy programme on the market share of efficient 4.5Ltoilets

	2009			2013		
Flush Volume	Units sold	Market Share (No Subsidy)	Market Share (With Subsidy)	Units sold	Market Share (No Subsidy)	Market Share (With Subsidy)
6l	27,000	8%	8%	27,700	8%	8%
6/4l	304,200	90%	86%	301,600	87%	83%
4.5l	6,800	2%	6%	17,300	5%	9%
Total	338,000	100%	100%	346,600	100%	100%

Source: GHK based on data from: Market Transformation Programme (2008) Actions to improve water closet design and efficiency

The increased sale of 4.5L toilets could reduce London's annual water demand by an average of 300,000[35]m^3 compared to the projected base scenario. A total of 9,200 ML would be saved over the lifetime of the products (London household water demand is around 1.4 million m^3 per day). This would save water companies around £14 million over

[33] All charges calculated using 10/12/2008 exchange rates.

[34] Total rebates minus business as usual sales from Table 3.4 for the five year period.

[35] GHK Calculations not peer reviewed

16.5 years (the lifespan of the average toilet)[36]. The net present value of this savings is £6.5 million[37]. Dividing the net present value by the total number of rebates gives a rebate of £44 per toilet[38].

A subsidy of £44 for London represents 16% of the average retail price of a 4.5L toilet (£275) and 40% of the price difference (£112) between 4.5L and 6/4Ltoilets[39]. The subsidies for toilet replacement programmes ranged from £26 in Calgary to £86 in Austin. Similar subsidy programmes in Sydney and Austin found that a rebate of around 50% of the priced difference was sufficient to entice consumers to purchase high efficiency washing machines.

Eligibility for the Subsidy

Case study cities' programmes were open to all households within their city with toilets that met their eligibility criteria. To eliminate the possibility of consumers receiving funding for toilets that are not eventually installed, London should follow the case study examples and require recipients to submit proof of purchase and installation by an accredited plumber to receive the subsidy. Although the average household in London has one toilet, some homes have two or more bathrooms and this fact should be accommodated for in the subsidy design.(The absence of a single authority or system in the UK for accreditation or licensing of plumbers, is a potential barrier to future incentive schemes. It is recommended that efforts are made to introduce a single recognised licensing scheme for UK plumbers).

The case study cities found that commercial property owners were more responsive to financial incentives for installing efficient technology than homeowners. In 2007, 57% of London dwellings were owner occupied, 20% were private rented, 23% were social rented compared to nationally of 70%, 13% and 17% respectively[40]. Due to this high proportion of rental housing stock, London could follow Calgary's example and ensure that landlords are eligible for the programme. As property owners rather than tenants incur the costs installation, tenants should be ineligible for the subsidy.

Overall Budget

The total value of the subsidies for a London toilet subsidy programme will be around £6.5 million. In the case study cities, the marketing and administration costs for toilet replacement programmes ranged from 7% to 25% of the overall programme budget. To be conservative and to allow for adequate marketing of the programme, we have estimated marketing and admin costs at almost 25%, giving a overall programme cost of £8 million.

Options for Distributing the Subsidy

There are two main mechanisms for delivering a toilet replacement incentive: post-installation and pre-installation. Either of the two could be used in a London toilet rebate programme, but with different implications for its target market and administration costs.

All the case study cities, except Austin, exclusively used post-installation mechanisms to deliver water efficiency subsidies. Homeowners preferred discounts on water bills, while landlords preferred direct rebates as they were not required to pay water bills. These

[36] BN DW WC: Actions to improve water closet design and efficiency - Briefing Note relating to Policy scenario objectives in Policy Brief Hwww.mtprog.comH

[37] Assumes a discount rate of 3.5%, as given in the HM Treasury Green Book.

[38] Calculation: £6.5 million divided 148,000 rebates.

[39] 4.5L toilet costs £275 on average and 6/4L toilet costs £163 on average. Price data based on review of retailer pricing and discussions with Bathroom Manufacture Association representative.

[40] OMDP, 2008 Live tables Dwellings HBy tenure and region, from 1991

mechanisms are less accessible to lower income families due to their upfront investment cost. However, they were preferred by the cities as they reduced administration costs by eliminating, or greatly reducing, the need to do post-rebate inspections.

Vouchers were the only pre-installation mechanism used by the case study cities. However, several other mechanisms could be used for a London programme, including partnerships with retailers to reduce unit price. With the pre-installation mechanism, there is little control over where or whether toilets are eventually installed, or the old units destroyed. There is also the possibility of unscrupulous middlemen not passing the savings on to consumers or selling the discounted fixtures outside of London.

Potential Synergies

A study by Waterwise UK[41] found that the most successful water efficiency programmes were delivered through partnerships with the relevant entities. Both York Region and Austin programmes were delivered through partnerships with water companies, energy companies and municipal governments. Given that devices like water efficient showers also save energy, it will be beneficial to have multi-utility partnerships for a London-wide scheme. This could also save administration costs as organisations like the Energy Saving Trust and energy utilities already have well developed channels for providing incentives, education and raising awareness.

The subsidy also has the potential to be marketed in conjunction with other programmes, such as targeting residents of high water use areas (water/energy audits) or promoting household metering. Subsidies could be offered in conjunction with meter installation processes, or even through carbon-reduction programmes, .eg. insulation offers.

External Benefits of Scheme

Metered customers will benefit through reduced water charges. Replacing a 9L toilet with a 4.5L toilet could save the average metered London household, £42 per year, £9 per year more than if they replaced an inefficient toilet with a standard 6L toilet.

A 5% market shift towards the purchase of 4.5Ltoilets could save an estimated 8.4Gwh of energy and 3,735 tonnes of CO_2 emissions[42], over 5 years, through saving on treatment and pumping. The reduced water demand could also lead to lower volumes of water being abstracted from the environment, also offsetting potential increases in future demand..

Addressing Issues

There are three issues that would need to be addressed to maximise the benefits of a toilet replacement scheme – product labelling, product availability and plumber registration.

Labelling: mandatory product labelling programmes in the case study cities facilitated consumers choosing products that were more efficient. While the Bathroom Manufactures' Association in the UK has initiated a voluntary labelling system, it is not currently in place at the retail level nor does it distinguish between different levels of water efficiency.

Product availability: Waterwise UK and the Environment Agency have all found that aesthetics have a strong influence on consumers' choice of toilet model. Currently manufactures have focused on dual flush toilets, and there is a limited choice of styles for efficient 4.5Lsingle flush toilets. This lack of consumer choice could potentially be a deterrent to consumers.

Plumber Registration: Although there are several registration schemes for plumbers in the UK, none are mandatory and the schemes are generally not widely recognised. There

[41] Waterwise (2008), Evidence base for large-scale water efficiency in homes.

[42] Waterwise (2008): Water supply/disposal energy use 0.905 Kwh per m^3 and CO2 emissions 0.404 Kg per m^3

would be great benefit for having a single mandatory registration/licensing scheme for plumbers, to ensure consistent and high levels of product awareness and work quality.

3.3.3 Designing a Subsidy Scheme for London – Water Efficient Showerheads

Nature of Subsidy

The case study cities' programmes were designed to promote the replacement of older inefficient showerheads currently installed in households with more efficient products, mainly for reasons of water efficiency. An estimated 90% of London homes with showers have not installed efficient showerheads, as of 2009[43]. This means that there is a large pool of households with the potential to retrofit their showers. Additionally, replacing a showerhead is a water efficiency project that a homeowner or tenant can do themselves, with minimal disruption and expense. A subsidy programme aimed at properties that do not currently have an efficient showerhead could capture a sizeable proportion of the potential market.

There are three methods of delivering subsidised showerheads to London households,

1. Through mail outs of products to home
2. Through retailer promotions , or
3. Through household energy and water efficiency audits.

Programmes in the case study cities, that directly mailed efficient showerheads to eligible households had a low level of uptake and therefore water savings. This was primarily due to householders not installing the devices. It is therefore not advisable for London to use this method. Retailer promotions and energy efficiency audits both have the benefit for the programme funder of subsidising the wholesale rather than the retail price of the showerheads. The retailer promotion system would also give consumers a greater degree of choice in the model of showerhead. This system would have the additional benefit of being a loss leader for retailers, increasing the number of consumers into retail stores who would be likely to buy other products. However, the energy efficiency audit system would have the advantage of guaranteeing that the efficient showerheads are installed. For these reasons it is recommended that the London showerhead subsidy programme be delivered through a combination of retailer promotions and home energy/water efficiency retrofit programmes/audits.

Consumers should be required to surrender their showerhead at the retailer, to receive an efficient showerhead. This would be to prevent households from not installing the subsidised showerhead, and to facilitate recycling of the showerheads. The subsidy should be available over 5 years, as the average showerhead in London is estimated to be replaced every five years due to the high mineral content in London water[44]. In order to prevent London households from reverting back to inefficient models when they replace the subsidised shower systems, it is recommended that initiatives be considered to promote the purchase of shower systems that include efficient showerheads.

In order to be eligible to receive the subsidy, retailers would need to prove that they stock efficient showerheads, and they would be required to display programme promotional

[43] GHK estimate based on discussions with the Bathroom Manufactures Association, the Environment Agency and the Market Transformation Programme.

[44] Based on discussions with the Bathroom Manufactures Association representatives. While reliable estimates for the sale of replacement shower systems are available, there are not similar figures for the sale of replacement showerheads. However the wide range of retail replacement showerheads would indicate that there is a market for this type of product.

material in store, and if applicable online. The retail would then receive the wholesale price they paid for the water efficient units sold up to the value of the subsidy.

Coverage of the Subsidy

While the vast majority of households in London have shower systems installed in at least one of their bathrooms[45], not all can be retrofitted by installing an efficient showerhead. There are two types of shower systems used throughout the UK, mixer showers and electric showers. While nearly all mixer showers can be retrofitted by installing efficient showerheads, electric showers cannot, due the mechanical design of the showers. The bath/shower mixer category includes systems which are designed to adapt baths to showers by installing a plastic hose directly over the bath taps[46]. The flow rate of these systems is dependent on the flow rate of the bath, which is controlled by the bather, and is not mechanically adaptable to efficient showerheads.

Table 3.7: Average flow rates[47] for various shower systems sold in the UK

Mixer Shower type	**2006 Flow rate estimate L/min**	**Electric Shower type**	**2006 Flow rate estimate L/min**
Gravity	7.9	7.0-7.9 kW	3.5
Integrated pump	9.9	8.0-8.9 kW	4.0
Separate pump/pressurised	11.8	9.0-9.9 kW	4.5
Bath/shower mixer	6.0	10.0 kW+	5.0
Average	**9.6**	Average	**4.3**
Average of systems included in subsidy (excluding Bath/shower mixers)	**9.9**		**NA**
Source: BN DW Shower: Actions to improve shower design and efficiency, 2008			

The highlighted sections in table 3.7 are the three shower systems, which are mechanically adaptable to efficient showerhead. It is estimated that 1.1 million households in London (37%) have shower systems that are compatible with efficient showerheads. All households with this type of shower should be eligible to receive a free showerhead. However it is not anticipated that all households, who are eligible for the subsidy will participate or that all household that participate would install their showerhead. For these reasons it is assumed that 900,000 or 80% of the eligible households would install and use the subsidised showerhead. The incentive estimates a relatively ambitious take-up of showerheads as they would be free at the point of sale compared to the low efficiency alternatives.

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[45] 93% of flats and 98% of houses will have at least one shower per household. (Source: BNWAT28: Water consumption in new and existing homes, 2008)

[46] While there are more expensive bath tap systems which could be retrofitted, discussions with stakeholders revealed that there were not any reliable estimates of the proportion of units in this category could be retrofitted. For this reason and to be conservative, the Bath/shower mixer category was excluded.

[47] There are also shower systems with considerably higher flow rates.

Value of Subsidy

Through a review of the websites of major UK retailers and discussions with stakeholders, the average wholesale price of an efficient showerhead is £10 per unit. The value of the rebate would need to be a minimum of £20 if given directly to consumers and £10 if given to retailers. As analysed in the following subsections, the costs of a subsidy programme based on the wholesale price of units would be well below the economic benefits to the funding body.

In order to induce homeowners and tenants to purchase and install efficient showerheads, the devices would need to be offered for free. In all the case study cities, where they were available, replacement showerheads were offered free of charge. The average retail price (including VAT) for an efficient showerhead is £20 per unit[48].

Carbon benefits of the Programme

At a household level, installing an efficient showerhead will result in significant environmental savings. A London flat would save between 5 and 22 m^3 of water per year, while a London house would save between 8 and 31 m^3 of water per year[49]. This would result in annual household energy savings of between 141 and 658 kWh for flats and 232 and 922kWk for houses. This variation reflects differences in showering frequency, shower length, water pressure and the flow rate of the inefficient shower previously installed in individual households.

Switching 900,000 household to efficient showerheads would reduce London's water demand by approximately 67,700 megaliters over 10 years. Annual water demand would be reduced by an average of 7,500 megaliters[50]. It is anticipated that due to a marketing push in the initial years of the programme, the majority (75%) of the subsidies would be distributed in the first two years of the programme. Based on the projected five year uptake, water savings would peak at 13,500 megaliters[3] in year 5 of the programme, and fall to 800 megaliters in the final year of the programme.

Table 3.8: Projected programme participation and savings

		Rebates given PA	Showerheads in use PA	Water Savings	Energy Savings	CO_2 Savings
		No	No	Megaliters	GWh	Tonnes
Programme Total (10 years)		916,000	916,000	67,100	2,100	405,000
Annual Distribution	2010	50%	50%	10%	10%	10%
	2011	25%	75%	15%	15%	15%
	2012	12%	87%	17%	17%	17%
	2013	6%	94%	19%	19%	19%
	2014	6%	100%	20%	20%	20%
	2015	-	50%	10%	10%	10%
	2016	-	25%	5%	5%	5%

[48] Based on a review of retailer web and in store pricing, by GHK.

[49] Water savings calculated based on data from the MTP, and discussions with stakeholders, where there was conflict between data sets the more conservative numbers have been used.

[50] GHK Calculations

	2017	-	12%	2%	2%	2%
	2018	-	6%	1%	1%	1%
	All years	100%	100%	100%	100%	100%

Reducing water consumption for showers will be also reduce energy consumption by 2,100 GWh over ten years through reducing energy consumed to supply and heat water. The majority of the savings will be through reductions in the energy consumed domestically to heat water. Over ten years a total of 2,000 GWh[51] of energy will be saved. An additional 61 GWh[52] of energy will be saved through reducing the volume of water supplied to London households. A total of 405,000 tonnes of CO_2 will be saved over ten years, through these energy reductions.

Economic Benefits

Water savings from the programme could be worth around £99 million over 10 years. The net present value of this saving is £87 million[53]. These savings will accrue to Water Companies except for the approximately 24% of London households which are on metered billing, where water savings would accrue to households.[54] Households on water metering would save between £7 and £45 per year[55], but for non metered households this would be £0. In addition an average household would save £41 per year in energy costs[56] irrespective on whether they had a water meter or not. Although, the rate of water metering is planned to increase in London, it is not likely that the changes will be implemented before the end of the potential rebate programme. The net savings for London water companies will be around 76% of the total savings or £75 million over 10 years. The net present value of this savings is £66 million[57].

Additionally, the CO_2 emissions savings from the programme could avoid damage to the environment estimated at £12 million in savings using the shadow price of carbon.[58]

Overall Budget and Costs and Benefits

Assuming that the subsidy is paid to retailers, the cost of the rebate will be £9.2 million. The total cost for a London showerhead subsidy programme will be around £11.4 million, including administration costs. In the case study cities, the marketing and administration costs for toilet replacement programmes ranged from 7% to 25% of the overall programme budget. As the eligibility criteria is stringent, and will entail high marketing costs, the administration cost is more likely to be at the higher end of this range.

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[51] GHK Calculations: 30kWh are required to heat 1 m^3 of cold water. Calculated based on data in ARUP 2008 Report: Your home in a changing climate.

[52] GHK Calculations: 0.90 Kwh are required to supply 1 m^3 of cold water. Calculated based on Data from Waterwise UK.

[53] Assumes a discount rate of 3.5%, as given in the HM Treasury Green Book.

[54] Based on report from Thames Water cited in article by Helen Monks Saturday, 18 March 2006 Hhttp://www.independent.co.uk/money/invest-save/water-meters-water-meters-everywhere-470284.htmlH

[55] Assumes water rates of £1.48 per m^3

[56] GHK Calculations: assumes energy costs of £0.0923 per kWh based on data in ARUP 2008 Report: Your home in a changing climate and a review of average energy bills from London based utility companies.

[57] Assumes a discount rate of 3.5%, as given in the HM Treasury Green Book.

[58] GHK Calculations: Calculated based on data in GHK 2008 Economic Valuation of Environmental Impacts in Project Development, Appraisal and Evaluation Yorkshire Forward

A budget of £11.4 million would result in an overall benefit cost ratio of 6.7 when the shadow price of carbon is included. When only the savings due to reduced water use are considered, the benefit cost ratio is 5.8.

Potential Sources of Funding

The international case studies used in this study highlight that water suppliers have been the primary source of economic incentives for water efficiency. However the limitations of the UK water regulatory framework disincentivises significant investment by the water companies in water efficiency and demand management options. By assessing what benefits are delivered through water efficiency improvement in the house, key sectors and organisations can be identified as having a potential role in working together to incentivise water efficiency.

There is benefit alone to the household for retrofitting water efficient items (showerheads and toilets), through reductions to their energy bills from reduced hot water usage, and reductions in their water bills if they are metered. However, as the accelerated uptake of water efficiency devices and more sustainable behaviours is desired as climate change adaptation and mitigation actions, the funding of economic incentive schemes to facilitate this, should be investigated by a number of sources.

Although it is not within the scope of this study to identify specific funders and pots of money, government sectors (central, regional and local), and London's water and energy utility companies do have potential to benefit from facilitating incentive based schemes.

Funding from various government levels and organisations to deliver water efficiency improvements would help offset the risk of long-term water scarcity. This same funding would also help deliver carbon reductions within the domestic sector, which is London's largest combined carbon emitter.

Under the revised Water Company Business Plans 2009-2014, Ofwat are setting water efficiency targets for each water supplier. The implementation of economic incentive schemes and options to increase the installation of water efficiency devices in London's existing homes, could be used by a water supply company as a key mechanism for achieving the Ofwat targets.

The co-benefit of reducing carbon emissions through improving hot water efficiency, is something that could be exploited by London's energy suppliers in helping deliver their CERT commitments.

All potential funders and mechanisms may also benefit in a combined or partnership approach for both new schemes or in utilising existing deliver mechanisms, such as a pan-London Homes Retrofitting Programme.

Potential Synergies

The York Region, Austin and Queensland programmes were delivered through partnerships with water companies, energy companies and local governments. Many borough councils and energy suppliers servicing the London area are planning to initiate home energy audit programmes over the next five years. Partnering with such programmes would provide an effective mechanism for installing a free showerhead received through the retailer promotions.

Given that devices like water efficient showers also save energy, it will be beneficial to have multi-utility partnerships for a London-wide scheme. This could also save administration costs as organisations like the Energy Saving Trust and energy utilities already have well developed channels for providing incentives, education and raising awareness.

3.3.4 List of interviewees:

Nicola King, Market Transformation Programme

Mike Rymill, Bathroom Manufactures Association

Jonathan Dennis, Environment Agency

Dan Strub, Austin Water Utility

Michael Brooks, York Region's Water for Tomorrow Programme

André Boerema, Sydney Rebates and Water Wise Programme

Keith Colquhoun, Thames Water

Lesley Tait, Thames Water

4 FLOOD RISK MANAGEMENT

4.1 Introduction

Increased urbanisation and the changing climate have increased the risks of flooding. Increased urbanisation results in reduced water absorption capacity, leading to more surface water runoff and increased flooding. The increase in surface water runoff not only increases the risk of flooding, it also increases the stress on the sewage system. UKCIP02 projections show that tidal, fluvial and surface water flood risk is likely to increase in the future as sea levels rise.

As part of the first phase of the Government's strategy for flood risk management, '*Making Space for Water'*, Defra initiated a £500,000 pilot grant scheme for the implementation of property-level resistance and/or resilience measures. This is discussed in detail in the Annex. The aim was to explore approaches to implementation and to assess the likely take-up by property owners.

4.1.1 Risks and impacts of floods

Much of London is built on the floodplain of the Thames and its tributaries and is prevented from flooding by a complex system of flood defences. In principle, London is at risk from flooding from five sources:

- the sea (tidal flooding)
- the Thames and tributaries of the Thames (fluvial flooding)
- heavy rainfall overcoming the drainage system (surface water flooding)
- the sewers
- rising groundwater.

In London, there are flood defence measures in place against two major kinds of flooding: tidal flooding[59] and fluvial flooding[60]. London is protected from tidal and fluvial flooding of the Thames and its tributaries by comprehensive flood defences which includes the Thames, Barking and Dartford Barriers. It is currently estimated that 98 per cent of East London is protected to a very high standard from tidal flooding (against a 1 in 1000 year flood) with 95 per cent of defences known to be in good condition in the London region[61].

According to the draft London Climate Change Adaptation Strategy, around 481,180 properties and 1.25 million people are at risk from tidal and fluvial flooding in London. However, around 82% of these properties are at 'low' flood risk. On the other hand, approximately 100,000 homes are at 'moderate' or 'significant' risk i.e have low standards of protection, little warning time and relatively few management options.

Full mapping of surface water flood risk is not yet available, but as a result of the Pitt review into the Summer 2007 floods in England, the Environment Agency is leading on risk mapping and the preparation of Surface Water Management Plans in conjunction with Defra and local authorities. In future therefore, more intelligence on the threat from surface water flooding, and strategies to manage it will be available.

[59] Occurs when high tide and storm surges coincide.

[60] Occurs when rivers overflow due to high or intense rainfall

[61] Making Communities Sustainable. Managing flood risks in the Government's growth areas, Association of British Industry (ABI) February 2005 op cit, figures based on Environment Agency information.

A London Assembly scrutiny report in 2002[62] identified the impact/costs of the three main types of flood risk (see Table 4.1 below), should such flooding take place and the likelihood of it occurring.

Table 4.1: Likelihood of flooding and costs in London

Type	Likelihood of event	Likely Costs
Tidal	Low	Very High
River	Thames- Low Tributaries- Medium to high	High but localised
Drainage	High in certain locations	Medium but localised

The most immediate and significant flood risk to London comes from drainage flooding. There are also localised areas which are vulnerable to river flooding. There are obviously higher costs and impacts when two or three of these differently sourced floods occur at the same time. According to the ABI, UK annual costs for extreme flooding events are expected to increase from £1.5 billion today to £4.5 billion in 2050 and from £5 billion to £40 billion for extreme coastal flooding events.

4.2 Defra Grant Scheme

Following the consultation, Defra announced a £5 million property-level flood protection grant scheme that will provide financial help to properties in high flooding risk areas without community-level defences. This scheme builds upon 'Recommendation 12' of the Pitt Review and the recent consultation on policy options for promoting property-level flood protection and resilience. There will be at least two funding rounds for this grant scheme:

- First round: allocation of £2 million, applications for this round closed on 17th March 2009.
- Second round: allocation of £3 million, expected to launch in autumn 2009.

The grants will cover fluvial and coastal flooding, sewer flooding, surface water flooding and groundwater flooding.

4.3 Relevance to London and the UK

We were unable to model a London-specific scheme for flood risk management due to data issues. A key challenge for developing a model for such a scheme would be the availability of data on the level of pluvial flooding in London. The Drain London Project, jointly led by the GLA, Thames Water and the Environment Agency, will establish what data are available for London. The following EA National Flood Water Risk Mapping programme will later provide more detailed data which will help potential incentive schemes.

Notwithstanding, this is highly relevant to England as Defra has already consulted on setting up an English grant scheme which would include London households and presumably be funded by national government in a similar manner to flood defences. On that basis, though, it does not seem of value to develop a separate London model for implementation in London. The Defra scheme is aimed at households at risk from all forms of flooding. However, not all flood defence/property resilience projects will fall under this grant scheme. This scheme, although very important, will not meet all the prioritising criteria for Defra/EA funding. Therefore local authorities may need to investigate and lead alternative funding or incentive options to pay for community defence and/or property level resilience schemes.

[62] Hhttp://www.london.gov.uk/assembly/reports/environment/flooding.pdfH

The main risk for London is from pluvial/surface water flooding due to inadequate protection. With the increasing volume and intensity of winter rainfall predicted due to climate change (40% increase in risk for winter rainfall in the Thames catchment by the end of the century), the issue of pluvial flooding is likely to become increasingly important in adapting to climate change.

Sewage undertakers, Thames Water in the case of London, are currently responsible for preventing pluvial flooding, although this may change following the Pitt Review. In a similar way to fluvial flood prevention, it may be more cost beneficial in some circumstances to provide property-level flood prote ction rather than investing in area-level works to reduce pluvial flooding. Such a scheme would need the support of all governance levels and utility companies.

4.4 Recommendations for London

- Defra's recently announced extension to their flood resilience programme should be carefully monitored to review the properties eligible for funding and the nature of flood risk covered.
- The insurance sector should further consider 'risk based pricing' as a means of encouraging property owners to increase property level resilience and exposure of home/buildings in flood risk areas, including surface water flood risk areas.

4.5 List of interviewees:

Tim Harries, Flood Management, Defra

John Goudie, Engineering Policy Advisor, Defra Flood Management Division

ANNEX 1: LONG LIST OF CASE STUDIES

Overheating

- Toronto green roof incentive pilot program
- Chicago green permit programme
- Indian wells home energy assistance link (h.e.a.l),

Water efficiency

- Waterwise Rebate scheme for homes, Australia
- Sydney water conservation programs, Australia
- Water efficency rebate scheme for homes, Southern USA
- Water efficency rebate scheme for homes, Northern USA
- Water for Tomorrow Programme, York Region Canada
- Reducing Water demand in Calgary- the “Water Meter Incentive Programme” (WMIP)
- Blocked rate Water pricing structure, USA
- Built Green Programme, Calgary Canada
- Sustainable Building Tax Credit, New Mexico USA

Flooding and drainage

- Defra flood resilience pilot funding scheme, UK
- Surface water rebate Programmes, UK
- National Flood Insurance Programme (NFIP), USA
- Soil Depth Initiative, Austin Texas
- WaterWise Landscape Rebate Program, Austin Texas

ANNEX 2 – MAIN CASE STUDIES

Summary of main case studies

The Case Study	Assessment	Relevance to London and UK
Toronto Green Roof Incentive Pilot Programme, Canada	100% up-take of grant scheme achieved but a limited scheme with a budget of about only £110k pa. Pilot provides evidence on the levels of grant required for large scale uptake.	Relevant to London and potential GLA/LDA funding sources. Would need to be targeted in low green space areas with high levels of flat roofs for net economic benefits. Potential for loan scheme jointly with targeted councils
Water Efficiency Rebate Programmes, Various	The most successful programme had a basic retrofit service but with extensive marketing. More extensive water efficiency schemes could be justified on the basis of the costs of alternative supplies.	TW currently provides free cistern displacement devices and plan to provide free water saving shower heads. GLA, water companies, EA and energy companies could consider wider subsidies eg for more efficient washing machine replacements, minimum flow toilets, based on the higher costs of supply for London.
Defra Flood Resilience Pilot Funding Scheme, UK	Pilot achieved a high uptake of grants for resistance, but a low uptake of resilience measures. Pilot did not provide evidence on the optimum funding model. (Programme is not yet mature or large enough to provide robust optimum funding and cost-benefits)	Defra to take forward English scheme but not covering surface water flooding. Potential for Thames Water (TW) or EA, post Pitt, to fund a similar scheme to cover surface water flooding in London. Key challenge would be data on surface water flood risks - via Drain London Project and EA National Surface Water Flood Risk Mapping programme?
The National Flood Insurance Programme, US	This scheme only insures 49% of households in high risk flood zones cf ≈ 100% in the UK. In areas covered, estimated 80% decrease in property damage costs.	Different model in the UK where private insurers agree to provide insurance based on government commitment to 'adequately' fund flood risk management. This case study would only be relevant if this agreement broke down. Potential lessons for private insurers in requiring resilience and resistance measures in previously flood damaged buildings.
Calgary Water Meter Installation Scheme, Canada	Guarantee to fund any increased costs due to a meter, seems to have doubled the rate of uptake of voluntary meters compared to the English average over the same period.	TW plans to increase metering from 27% in 2010 to 54% in 2015 based largely on compulsory metering not compatible with an incentive for voluntary metering. Incentive scheme could be relevant in the short-term or if TW is unable to use compulsory metering and has to revert to voluntary approach.

Toronto Green Roof Pilot Incentive Programme

Context and objectives

Aim: The overall goal of the Green Roof Pilot Incentive Programme was to encourage green roof construction in the city. In addition, the programme was directed at:

- Supporting the construction of a variety of green roof types which could be used for educational and promotional purposes;
- Providing an opportunity to showcase various green roof technologies and planting styles;
- Including roofs ranging from an expansive industrial/commercial roof down to a small single-family residential application.

Context: In November 2005, Toronto City staff presented a discussion paper entitled "Making green roofs Happen" to Toronto's Roundtable on the Environment. This led the City Council to adopt a Green Roof Strategy on January 31, 2006. One of the main recommendations of the Green Roof strategy was the creation of a financial incentive programme for property owners wishing to install a green roof.

In parallel to the Green Roof Strategy, the City Council's Executive Committee formally launched the process for engaging the community in developing a climate change and clean air action plan. Providing financial incentives for green roofs was among the key initiatives identified for reducing greenhouse gas emissions in the action plan.

Economic driver: A cost-benefit study by Ryerson University in 2005[63] quantified the benefits of Green Roofs, looking at the reduction of: the urban heat island effect; storm water runoff; and energy consumption. This study, using unit cost data from the city's Wet Weather Flow Master Plan, estimated an equivalent saving in stormwater management costs of about $1 to $2 dollars per square metre of flat roof area if all large flat roofs were retrofitted and sustained in perpetuity. This provided a basis for establishing the level of funding if a permanent grant programme were established. Although there are other benefits to green roofs, the main public economic driver of the Toronto programme was and continues to be reduced storm water management costs.

Inputs, activities and outputs

The grant programme for green roofs had a total annual budget of CAN$200,000 (£99,800)[64] . No additional funding was provided to administer the programme and summer placement students were used for some of the programme activities, such as taking photographs and surveys. A Communications Strategy was prepared for the Green Roof Incentive Pilot Programme, including an advertising campaign and targeted distribution of the printed information.

The financial incentive available in the first year (2006/07) was CAN$10 (£5) per m^2 square metre to a maximum of CAN$20,000 (£10,000). In the second year, the financial incentive was increased to CAN$50 (£25) per m^2 and a maximum limit of CAN$10,000 (£5,000) was set for a single family residential and up to CAN$100,000 (£49,900) for multiple-family residential, industrial or commercial buildings. This increase was due to the low level of applications for large buildings in the first year. Grants were available on a first come first served basis until the budget was exhausted.

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[63] 'Environmental Benefits and Costs of Green Roof Technology for the City of Toronto'

[64] For this section all Pound equilivant are caculatted using 2006-Jan -02 exchange rate of 1$CAN =0. .499143 GBP found at Hhttp://www.x-rates.com/cgi-bin/hlookup.cgiH

Any private property owner in the City of Toronto with a water account with the City was eligible, regardless of building size and type, so long as the building was capable of supporting a green roof that met the following specifications and requirements:

- Had a continuous coverage of growing media over at least 50% of the roof footprint (roof area) of the building;
- Had a vegetation mix as opposed to a monoculture and a sustainable organic growing medium that replenished nutrients and retained moisture;
- Had a maximum slope of 10 percent;
- Had a depth of at least 150 mm (6 inches) for a new building;
- Was installed over heated spaces (non-heated spaces, such as underground garages, were not considered for the pilot programme).

Outcomes and Impacts

Take-up of grants

In the first year (2006-2007) of the pilot programme, 16 successful candidates were approved as programme participants. This included residential, commercial and institutional green roofs with a total of 3,000 square metres of green roof area.

In the second year, a total of 30 successful applications were approved out of 42, resulting in the construction of 16 new green roofs in the City of Toronto by the end of 2007. The majority of applications received were still for single family residences; everything from small green-covered patios to full roof coverage. Overall, applications were made for just under 12,000 m^2. Of these: 27 were for single family residential properties; (total 2,030 m^2), three were multiple family residential properties (1,556 sq. m) and 12 were institutional/commercial developments (8,379 sq. m). The single largest application was for Victoria Park subway station, which is proposing to construct a green roof approximately 2,550 square metres in size, as well as a canopy of about 760 square meters. There was a significant increase in applications from large commercial buildings in the second year mainly due to the increase in grants. Of the total applications, 12 applicants had to be turned down as the budget was exhausted. If Toronto Water had financed all the applications it would have cost CAN$ 600,000 (£299,500).

All pilot programme participants provided detailed information about the installation of their green roofs as well as photographs, which have been posted on the City's website. Each applicant completed a detailed questionnaire providing construction and technical details that will assist City staff and other agencies in the development of future permanent programmes.

Economic impacts

The monetised environmental benefits from the Ryerson University study can be used to calculate the benefit-cost ratio of 16 new green roofs (3,000 m^2) attributed to the pilot programme in the first year. Assuming a discount rate of 4% over 40 years and installation costs of CAN$90 (£45) per m^2 gives a social benefit-cost ratio of 0.38[65]. This indicated that green roofs are not cost-effective and that the costs outweigh the benefits. The Ryerson University for the City of Toronto calculated the benefits of green roofs on the assumption that 100% of available green area is used (Table A1 below). Savings from building energy use and stormwater management provided the greatest benefits.

[65] Benefits only include: stormwater management, combined sewer overflow (CSO), air quality, building energy and urban heat island (UHI) effect

Table A1: Quantified Benefits of Green Roofs

Category of benefit	Initial cost saving (CAN$)	Annual cost saving (CAN$)
Stormwater management	118,000,000	
Combined Sewer Overflow (CSO)	46,600,000	750,000
Air Quality		2,500,000
Building Energy	68,700,000	21,560,000
Urban Heat Island	79,800,000	12,320,000
Total	**313,100,000**	**37,130,000**

Source: Environmental Benefits and Costs of Green Roof Technology for the City of Toronto', Ryerson University (2005)

Note: Stormwater management includes stormwater best management practice infrastructure saving, pollutant reduction benefit and savings from erosion control measures. CSO benefit is estimated by the reduction of underground storage for the same level of CSO control. Air quality benefits are based on the perceived cost to society of air pollution due to impact on health and environment. Building energy savings is attributed to the direct reduced costs of cooling and demand load reduction. UHI savings is measured by the indirect energy savings and calculated the same way as building energy savings Initial cost saving is related to one-off capital cost savings.

From the literature, there is considerable variation in the estimated benefit-cost ratios and life-cycle costs between green roofs and standard roofs. The private benefit-cost ratio found by Acks (2006)[66], in a study for the New York Metropolitan region, for the moderate case was 0.54 (low 0.38 and high 1.85), while the social benefit-cost ratio for a 50% green roof infrastructure scenario was 1.02 (low 0.66 and high 3.87)[67]. The Acks (2003) study calculated cost-benefit ratios based on the net present value of public and private costs and benefits. Private and public benefits were further divided into two tiers. Tier I included benefits and costs which appear to be more significant and well defined in the short term (Table A2). Tier II adds potential benefits such as improved air quality and public health, reduced greenhouse gas emissions, increased property values and aesthetic value. Three scenarios were used based on low, medium and high green roof performance.

Table A2: Benefit-Cost Ratios for a Green Roof Scenario for New York

	Tier 1		Tier 2	
	Cost	Benefit	Cost	Benefit
Private	▪ Installation costs; ▪ Service life; ▪ Architectural and engineering costs	▪ Energy Savings		▪ Sound Reduction; ▪ Food production; ▪ Private aesthetic benefits
Public	▪ Programme costs	▪ Urban heat island; ▪ Stormwater runoff capital costs; ▪ Stormwater runoff operating costs		▪ Greenhouse gasses; ▪ Air pollution; ▪ Health; ▪ Public aesthetic benefits

Benefit Cost Ratio	Performance Scenarios		
	Low	**Medium**	**High**
Tier 1 , Private	0.34	0.46	1.31
Tier 1 , Public	0.53	0.65	1.57
Tier 2 , Private	0.38	0.54	1.85
Tier 2 , Public	0.66	1.02	3.87

Source: Acks (2003)

66 Acks, Kenneth, Cost Benefit Group, LLC (2006). A Framework for Cost-Benefit Analysis of Green Roofs, Initial Estimates. Retrieved Apr. 26 2007

67 Benefits include, in addition to footnote 1: scale factor for reduction in installation and maintenance costs, reduction in greenhouse gases, health benefits and public aesthetic benefits.

The results showed that green roofs are cost-effective under the medium performance scenario only when the wider environmental benefits (Tier II) are included. They are also cost-effective under the high performance scenarios, which can be expected as the technology improves and costs falls over time.

There were however key private economic benefits that were not explicitly quantified in the Ryerson study:

- Extended roof life - Plants and soil act as a protective shield from the sun, rain and wind. This means no U.V. radiation/photo degradation of roofing components and minimal thermal contraction and expansion, which can double and in some cases treble the roof life;
- Reduced roof maintenance costs - Because of the protective nature of green roofs, they do not need to be resurface every 3-5 years as conventional roof.

A study by GLA found that green roofs for new builds are cost effective when the cost in use is applied over the life of the asset which is usually between 20-40 years[68]. On this basis, the net private cost of green roofs compared to standard roofs, would be zero, even though the initial upfront costs are much higher than for standard roofs.

The literature review in the Ryerson University (2005) report also indicated other benefits that could not be quantified. These benefits included: aesthetic improvement of urban landscape, increase in property values, benefits resulting from green roofs used as amenity spaces, use of for food production, and increased biodiversity. Further work is needed to quantify these benefits.

Overall it is likely that the benefits would outweigh the costs if:

- some of the above non-quantified benefits were monetised;
- installation costs fell due to larger production volumes (economies of scale); and
- energy prices or sewage discharge charges significantly increased.

Lessons and barriers

High installation costs are seen as a major barrier. The CAN$10 (£5) per m^2 financial incentive offered as part of the original pilot programme was insufficient to attract broad interest, particularly for large-scale projects, given the high installation costs. There was an improved interest for large-scale projects once the incentive was increased to CAN$50 (£25) per m^2. The interest with the initial low level of incentive seems to come mainly from small householders who had a strong preference to take environmental action in spite of the cost. However, the benefits from green roofs, particularly in terms of storm water management, are greater with larger inner city buildings.

The cities of Montreal and Chicago, also with higher incentives, seem to have more successful green roof incentive programmes although there is limited information available on these schemes. In Montreal, the utility company, Gaz Metro, provides a CAN$50 (£25) per m^{2}incentive and Chicago provides US$100 (£58)[69] per m^2 for its downtown buildings.

The programme manager of the Toronto Green Roof Pilot Programme suggested that the stop-start nature of the incentive programme was not the ideal way to increase uptake. A number of applicants had to be turned down once the budget was exhausted and would then have to re-apply in the following year if the grant scheme continued.

[68] GLA Living Roofs (2008) Hhttp://www.london.gov.uk/mayor/strategies/sds/docs/living-roofs.pdfH

Hhttp://prairieecosystems.pbwiki.com/Crerar+Benefit-Cost+AnalysisH

[69] 1$US= 0.581801 on Jan 2, 2006

The programme manager also suggested that the programme needed strong leadership and direction from local and central administration as demonstrated by the successful programmes in Chicago and Germany. In Chicago, the Green Roof programme is strongly driven by the Mayor and in Germany it is driven by federal environmental laws and incentives. The Toronto Green Roof Pilot programme has been actively supported by the Deputy Mayor but needed further political drive and initiative to build on the positive start.

Next steps

Based on the experience gained from administering the pilot programme and continued public interest in green roofs, an evaluation report[70] outlined some changes to the programme to help further promote green roof technology in buildings within the City, particularly within the industrial and commercial sectors. The report recommended in particular a review of the level of financial incentives and that other parties should be contributing funding to the programme in light of the benefits.

The Toronto Environment Office has now launched an 'Eco-Roofs' initiative which includes green roofs and other measures such as reflective roofs.

Overall assessment

This programme was relatively successful in terms of the take-up of grant funding at 100% and provides some evidence as to the level of grant necessary to ensure larger, more commercially orientated property owners participate. However, the evidence on the total net economic benefits of green roofs has not been calculated and needs further exploration. Furthermore, this is a relatively small scheme so the 100% take-up may not be so significant.

Rebates for Water Efficiency and Conservation – Various Cities

Introduction

A number of cities have introduced financial rebates ranging from 50% to 100% on approved products to help households, to make their homes and gardens more water efficient. This case study is based on the experience of water rebate programmes for the following cities/states: Sydney; Austin, (Texas); York Region (Ontario, Canada); Queensland and Calgary (Alberta, Canada). These locations were chosen due to their part-similarity to either London's governance structure, population, and/or water supply issues.

Context and objectives

Aim: The main aim of these programmes was to reduce peak day and average day water demand levels due to rising population and drought, thereby postponing the need to expand treatment plant capacity and alleviating pressure on reservoirs supplying the region.

Context: Most of the cities studied were and still are experiencing high population growth with water supply remaining relatively fixed. Unprecedented urban and upstream developments were putting additional pressure on their current water and wastewater infrastructure.

Economic driver: The escalating cost of supplying their population with drinking water is the main economic driver for the cities to implement residential conservation incentive programmes. Some cities (Austin, Calgary and York Region) purchase water rights, and

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[70] Hhttp://www.toronto.ca/legdocs/mmis/2007/pg/bgrd/backgroundfile-3302.pdfH

exceeding their usage rights could lead to either fines or higher payments. Several cities were also able to delay or avoid investing in new water treatment capacity.

The amount of money[71] that the cities would save through conservation programmes due to reduced costs of water infrastructure varies:

- Queensland[72]: £0.06 per m^3 conserved
- Sydney[73]: £0.24 per m^3 conserved
- Austin[74]: £0.12 per m^3 conserved
- York Region[75]: £0.38 per m^3 conserved

Queensland has little scope for investing in additional water supply capacity to deal with prolonged droughts. In contrast, in York Region there are additional water sources that could be accessed by investing in additional treatment capacity, but at high cost.

Additionally the economic growth potential of all the cities would be significantly reduced if they were not able to improve the reliability of their water supplies.

Environmental driver: All of the cities have relatively fixed water supplies, with limited capacity to extend their supplies in the long-term. Additionally, all case study cities are projected to maintain their levels of population growth into the long-term. However, climate change has placed a high degree of uncertainty on the upper limit of population that can be supported by their water systems, without conservation initiatives. Three out of five of the case study cities have experienced droughts that have depleted their water supplies during a time of population growth.

- **Austin:** during the months of July and August, water demand more than doubles due to lower rainfall and increased demand for water for irrigation.
- **Sydney**: a water conservation programme since 1999 has been in force due to worsening drought conditions and climate change.
- **Queensland:** the State's water supply is almost entirely dependent on dams that are susceptible to long droughts[76]. Previous high water usage, poor resource and urban planning and high population growth have compounded the current drought conditions and created severe water shortages, particularly in 2004.

Inputs, activities and outputs

Table A2 summarises the main aspects of each of the programmes, they involve subsidies for:

- Retrofitting or replacing toilets
- Replacing low efficiency showerheads
- Replacing low efficiency washing machines

[71] Based on November 2008 exchange rates and amounts when programmes operated.

[72] GHK calculation based on: South East Queensland Water Strategy Hhttp://www.qwc.qld.gov.au/myfiles/uploads/SEQWS/Chapter-4.pdfH

[73] GHK calculation based on: 2006 Metropolitan Water Plan Hhttp://www.waterforlife.nsw.gov.au/__data/assets/pdf_file/0019/1459/06mwp_chapter_7.pdfH

[74] GHK calculation based on: Water Efficiency in Austin, Texas, 1983-2005, AWWA February 2007

[75] GHK calculation based on: Regional Municipality Of York Water Efficiency Master Plan Update, April 27, 2007

[76] Hhttp://www.qwc.qld.gov.au/SEQ+droughtH

Rebate levels are reasonably comparable across schemes, although rebates for washing machine replacement tend to be lower, and rebates across the board are lower for Queensland. The value of a rebate was determined through pilot programmes and comparisons with similar programmes in other regions. However, Austin and Sydney arrived at the rebate value through an examination of: the value of the water conserved; the cost differential between efficient and non-efficient fixtures; and the prevailing market and economic conditions. In the case of cities with longer running programmes, the experiences of the initial phases of the programme were used to improve the subsequent phases. For example in Austin, the toilet rebate programme was amended to improve its accessibility to lower income households.

The percentage of the overall programme budget allocated to administering the programmes varied between the case study cities based on the size of the programme, the need to ensure the fixtures were installed, and the number of programmes administered.

Overall, the administration costs were lower for retrofitting programmes (York Region, Sydney Waterfix) then for programmes that required new fixtures to be installed. All rebate programmes required resources to verify that the efficient fixture had been installed and the inefficient one had been destroyed. For example, in Queensland, 7% of rebate applications were rejected through such processes.

The schemes vary significantly in size. York Region and Austin are the smallest, while Queensland is the largest and twice the size of Sydney's scheme. There is evidence from the York Region and Sydney programmes that the environmental benefits have been maintained, past the completion of the programme.[77]

[77] Based on discussions with programme stakeholders, other programmes are ongoing or have completed within the pas 12 month.

Table A2: Design and costing of each case study city programme

City/State	Programme Name	Dates	Products Covered	Rebate (% of Price)	Admin Costs (% Of Budget)	Av. Cost pa (£m pa[78])	Administered By
Calgary	Take It Out Cash It In	2004–08	Toilets	Up To 63%	22%	NA	City Of Calgary
York Region	Water For Tomorrow (Residential Retrofit)	1998-2002	Toilet Retrofit Devices Showerheads	100%	10%	1	York Region
Austin	Wash Wise	1998-2008	Washing Machines	Up To 20%	12%-25%	2	Austin Water (Private Company)
	Free Toilet	1994-2008	Toilets	Up To 100%[79]			
	Toilet Rebate	1992-2008					
Sydney	Waterfix	Single-Unit: 1998 - 2008 Social Housing: 2004- 08	Showerheads Shower Flow Restrictors Toilet Retrofit Devices Residential Leakage Repair	88%	6%-16%	3	Sydney Water (Publically Owned)
	Washing Machine Rebate Programmes	2002-08	Washing Machines	Up To 50%[80]	10%-28%	4	
Queensland	Home Waterwise Rebate Scheme	2006-08	Washing Machines Toilets Showerheads	Up To 50%	Na	14[81]	Home Waterwise Rebate Scheme
	Home Waterwise Service		Home Inspection And Repairs	100%	Na		

[78] Calculated using 11/11/2008 exchange rates (1£= 1.86 CAN$; 1.54 US$; 2.36 AUS$)

[79] Up to 50% off the cost of professional installation was also available

[80] Subsidy based on the price differential between efficient and inefficient washing machines

[81] Expenditures for rainwater tanks were excluded from the calculation as they were not applicable to London

Other key aspects:

Programmes were well marketed through relevant web sites, utility bills, retail outlets, published booklets, information leaflets, newspaper advertising and bill inserts through resident doors, direct mail, telemarketing and local print advertising.

All of the programmes imposed eligibility criteria for households to receive a rebate. In general, homes built after requirements for water efficient fixtures were implemented into building codes were ineligible. Some of the cities designed the programme eligibility criteria to support other water efficiency programmes. For example:

- Calgary: excluded customers billed on a flat rate from water conservation rebates in a bid to encourage consumers to switch to metered billing.
- Austin: required customers to install efficient showerheads and tap aerators as well as fixing leaks, prior to being eligible for other rebates.

Tenants in most of the case studies were either only eligible for rebates on a limited range of products (Sydney) or were eligible for products through separate programmes (Calgary).

Some cities faced opposition from manufacturers when rebates were restricted to "eligible" products. However, community support for the conservation initiatives has been strong in the cities. For example, worsening drought conditions and concerns over climate change have helped make water conservation a mainstream idea in Sydney.

Outcomes and impacts

The levels of take-up, environmental and monetary benefits attributed to the rebates is summarised in Table A3.

The levels of take-up reflect a combination of the available budget and the intensity of marketing. The York Region was particularly successful in achieving a high take-up level due to an intensive campaign of cold calling[82] of eligible households. In Queensland, uptake for rebated toilets and showerheads was low compared to other products offered through the programme. This may have been due to the fact that households had installed low flush toilets and low flow showerheads prior to the programme being put in place. Most of the rebate applications received (49%) were for rain water tanks (200,000) and grey water systems (2,700). These devices were not included in this analysis, as they would only be applicable to a small proportion of London's housing stock.

Environmental benefits, in terms of water saved per day, depend on the type of technology and level of uptake. Monetary benefits arise from the reduced cost of new infrastructure investments.

In all the case study cities, residential customers pay for water through a metering system. This gave an added financial incentive for households to decrease their water consumption. Some cities charged consumers on a blocked rate basis, where consumers are charged an escalating rate for consumption above a base level. In cities where blocked water rates were in place, such as Austin, households with the highest water consumption would have the greatest financial incentive to install rebated fixtures. In general, household savings were higher for fixtures that consumed energy (showers and washing machines) than for those that only consumed water (toilets).

[82] Cold calling refers to the process of approaching prospective customers or clients, typically via telephone, who were not expecting such an interaction.

Table A3: Monetary and environmental benefits of the case study city programmes

Cities	Type of rebate	Uptake % of eligible households pa	Household Savings on Water and Sewer charges[83] £/year/household	Environmental Benefits[84] m^3/day	Monetary Benefits for Authorities[85] Million £/day
Calgary	Rebate (Replacement Toilets)	2	Multi-unit: 69 Single-unit: 80	2,000	NA
York Region	Free: • Toilet Modification • Showerheads	12.5	54*	3,000	2
Austin	Rebate (Replacement Washing Machines)	NA	Multi-unit: 29 to 33* Single-unit: 3 to 22*	1,000	1
	100% Rebate (Replacement Toilets)		Multi-unit: 9 to 12 Single-unit:3 to 20	3,000	3
	Partial Rebate (Replacement Toilets)			2,000	2
Sydney	Rebate: • Showerheads • Shower Flow Restrictors • Toilet Retrofit Devices • Leakage Repair	2.5	28[86]	4,000	2
	Rebate (Replacement Washing Machines)	1.2	16*	3,000	2
Queensland	Rebate : • Replacement Washing Machines • Replacement Toilets • Replacement Showerheads Free (Leakage Repair)	 5 1 1 NA	 6 to 26* 8 to 20 41 to 159* NA	 9,000 3,000 1,000 NA	 5 1 1

[83] Estimated by GHK based on water and sewer charges information provided

[84] Calculated by GHK: shows water savings per day for each City/Region

[85] Calculated by GHK: based on the City's/Region's daily water savings and savings due to delayed infrastructure investments

[86] * Savings include energy as well as water and sewer charges

Lessons and barriers

In all cases, the water conservation programmes in all cases have led to significant market transformation in water using household products. The market share of more energy and water efficient products (e.g. 'A' or 4-5 star rated) had increased during the programme period.

Some of the programmes faced technical issues that affected the uptake or the water savings resulting from the programme. For example:

- In Austin, some of the toilets replaced through the programme would revert to inefficient levels of water use when the flapper component was replaced or damaged. This problem was subsequently overcome by eliminating rebates for any toilets whose flush volumes could be made inefficient by replacing the flapper.
- Queensland: the showerheads installed through the programme were not compatible with some– electric shower systems.

Overall assessment

Table A4[87] seeks to give an overall picture of the relative performance of the different schemes. Two key metrics are:

1. The cost of conservation: the cost of reducing water requirements by a cubic meter per day, through water efficiency measures
2. The cost of supply: the cost of supplying the same quantity of water with existing infrastructure

The relationship between the cost of conservation and the cost of infrastructure such as reservoirs, gives the benefit-cost ratio. A benefit-cost ratio greater than one implies that benefits from water conservation measures outweigh the costs of providing the same quantity of water with existing or new infrastructure.

In terms of the first metric, the costs of conservation are much lower for Calgary, York Region and Queensland. This seems to relate to a combination of more basic devices supplied with lower levels of rebate. The most expensive programme was Sydney's Waterfix scheme, involving plumbers going into homes to fix leaks and other appliances to minimise water use. Sydney's programme of washing machine rebates was probably estimated as more expensive than Queensland's due to different assumptions in terms of the type of washing machines being replaced (top loaders vs. front loaders).

On the second metric, where available, in all but two of the programmes the cost of conserving water was less than the cost of supplying it, i.e. the benefit-cost ratios was greater than one.

Overall, the most successful programme in terms of benefit-cost ratios was Calgary's toilet replacement rebate scheme, with a benefit-cost ratio of 42.9. This unusually high ratio is due to the combination of three factors:

- Calgary having the highest water supply cost of all the case study cities
- The high flushing volume of the toilets being replaced (19L compared to 9L in Australia)
- The low value of the rebate given (£27 compared to £87 in Austin)

87 Figures in this table should only be taken as broad guidance as they are sourced from different reports, potentially using different assumptions and methodologies.

Excluding Calgary, the most successful programmes in terms of benefit-cost ratios and take-up levels were the showerhead replacement programme in York Region (Canada) and Sydney's washing machine replacement rebate programme. Both programmes had benefit-cost ratios above three, but for different reasons. York Region's programme involved extensive marketing of basic free conservation devices, retrofitting toilets and replacing showerheads, which were relatively cheap and had significant water saving benefits. In contrast, Sydney's washing machine rebate programme was successful due to the relatively high cost of supplying water in the city. The other two washing machine rebate programmes (Austin, Queensland) were the only programmes to have a benefit-cost ratio of less than one. All three washing machine programmes had similar levels of per unit savings; however, the low cost of supplying water in Austin and Queensland reduced the economic justification for the programmes. However, their programmes were justified on the basis of avoiding the costs arising from water shortages in drought periods, which has not been taken into account in this analysis.

Table A4: Programme Benefit-Cost Ratios

Incentive	City	Programme Costs £ million	Unit Savings m3/day	Unit Life Years	Cost of conservation £/m3	Average water charge £/m3	Benefit-cost ratio
Toilets replacement rebates	Austin (100% rebate)	6	0.05	15	0.28	0.39	1.4
	Austin (Partial rebate)	3	0.05		0.21	0.39	1.8
	Queensland	2	0.08		0.14	0.28	2.0
	Calgary	1	0.18		0.03	1.17	42.9*
Toilet retrofit	York	3	0.03	5	0.14	0.29	2.0
Washing machine rebates	Austin	3	0.06	12	0.51	0.39	0.8
	Sydney	8	0.07		0.22	0.81	3.7
	Queensland	11	0.07		0.28	0.28	1.0
Showerhead replacement	York	3	0.05	7	0.09	0.29	3.1
	Queensland	0.4	0.03		0.18	0.28	1.6

Defra Flood Resilience Pilot Funding Scheme, UK

As part of the first phase of the Government's strategy for flood risk management, Making Space for Water, DEFRA last year funded a £500,000 pilot scheme to examine whether grants provided an effective means of increasing take-up of flood protection.

Context and objectives

Aim: To explore approaches for implementation and to assess the likely take-up of flood protection and resilience measures by property owners in the absence of community schemes.

Context: Initial estimates suggest that about half of the 400,000 households in England currently in areas identified as at significant risk (an annual chance of flooding greater than 1.3% or once every 75 years on average) might remain undefended by community-level flood defences. Of these, the 10,000 or so most at risk would experience the greatest benefit from taking up property-level measures. It should be noted that these figures do not include households that are potentially subject to pluvial flooding, i.e. flooding caused by the overflowing of drainage systems from intense rainfall events, for which there is a lack of data.

Economic driver: Where large-scale engineered defences cannot be economically justified, or are not viable, property-level measures are a cost-beneficial way of reducing residential and business exposure to flood risk where the likelihood of flooding is high (at least 2% per year, which is equivalent to a 1 in 50 year return period). Such measures can reduce flood damage by 50% - 80%[88]. Initial estimates suggest that, in England, this might apply to about half the homes that have a significant chance of non-pluvial flooding[89] and are undefended. The economic cost of flooding in these areas is considerable, currently around £747 million for residential properties.

Challenges: At present, few businesses and even fewer households take any steps to improve the flood protection or resilience of their properties. A survey conducted for DEFRA by Entec and Greenstreet Berman found that in areas of significant flood risk, only 16% of households and 32% of small and medium sized enterprises had taken any practical steps to limit potential flood damage. The Flood Protection Association has reported that fewer than 5,000 homes have, to date, taken approved measures.

Inputs, activities and outputs

DEFRA made £500,000 available for a pilot grant scheme for the implementation of property-level resistance and/or resilience measures. A funding limit of £5,000 per property was set, of which up to 20% could be used for surveys and administration costs. In practice, costs for surveys,[90] contract supervision and administration varied from 11% to 63% of the awarded grant sum. This is expected to be lower if undertaken for larger project values or done as a bulk order. Of the £500,000, the National Flood Forum was granted £10,000 to organise flood fairs and community engagements to increase awareness of protection and resilience options available amongst the target communities.

The funds were administered by the local authority working closely with the Environment Agency (EA) and the local community. Significant resources were provided by both the

[88] Entec and Greenstreet Berman (2008) *Developing the Evidence Base for Flood Resilience*, Research Report prepared for the Joint Defra/EA Flood and Coastal Erosion Risk Management Research Programme

[89] The exact figure will be clearer once the Environment Agency has completed its Long-Term Investment Strategy

[90] The cost of independent surveys was not separately recorded but informal reports for Bleasby indicated about £500 each if carried out as part of a bulk order and around £1,000 each if carried out individually.

local authorities (LAs) and the EA to run the pilots in terms of staff time, the funding of surveys and administrative overheads. A significant contribution towards the grant funding pot was provided by the Regional Flood Defence Committee (RFDC) for the Leeds pilot and top-up funding for works in excess of the grant provided by DEFRA was provided by Lancaster City Council (for Sunderland Point) and by the Environment Agency (for Bleasby, in particular).

Programme design

Six pilot locations were selected: Bleasby, Nottingham; Sandside, Kirkby-in-Furness, Cumbria; Sunderland Point, Morecambe, Lancs; The Dunhill Estate, Halton, Leeds; The Sands, Appleby, Cumbria; and Uckfield, East Sussex.

Four models were used for the funding allocation under the assumption that none of them would allow full funding of all demands. The funding mechanism for each pilot location was designed to make the grant as equitable as possible. It was chosen by the LA based on the number of eligible properties and total funds available. Each model was used for a specific pilot shown in brackets below.

Model 1: fully fund specific needs (e.g. flood barriers for doors, air brick covers.) but any other work (repointing of brickwork, etc) to be covered by property owner (The Dunhill Estate, Halton, Leeds pilot).

Model 2: Share funds available but offer a greater level of funding to those at higher probability of flooding. Funds are rationed based on level of risk (The Sands, Appleby and Sandside, Kirkby-in-Furness pilots).

Model 3: All eligible properties offered full funding for works agreed (Bleasby, Nottingham and Sunderland Point, Morecambe, Lancs pilots).

Model 4: All eligible properties were asked to commit at least 25% of the estimated costs of the works. Where the estimated costs exceeded £6,250 (£5k grant plus 25% minimum contribution) the property owner was expected to make up any shortfall (Uckfield, East Sussex pilot).

Outcomes and Impacts

Take-up of grants

The process of identifying and selecting the pilots started in April 2007. 240 properties were considered eligible for the scheme, of which 199 properties (83%) took up the grants. 177 of these were residential properties (89%) and the remaining 22 were commercial.

Five of the pilots completed their installation work by the end of March 2008, and submitted their draft reports by the end of April 2008. The sixth pilot completed installations in September 2008.

The average cost per property of works was about £2,900, in a range from about £300 to £13,000.

A rigorous comparison of the funding models in terms of take-up was not possible due to the range of pilot types. Differences included regional considerations, sea/river flooding in some cases mixed with pluvial flooding, private versus commercial properties. Overall higher individual grant levels resulted in a higher take-up. There was a strong feeling generally amongst householders that Government should fully fund such solutions.

Resistance versus resilience measures

Resistance was generally preferred in that there were no resilience-only solutions and where there was a mix, the resilience component was small (typically modified electrical systems – raised plugs and meters).

The fairs and community engagements organised by the National Flood Forum helped increase the knowledge and understanding of resistance and resilience approaches in the pilot locations.

There was a general emphasis on flooding defence systems (resistance) at these flood fairs, as most stands were taken by protection product suppliers, so the understanding of resilience is likely to have been less from that viewpoint. However, the National Flood Forum was also a presence at the flood fairs and as they are known to support resilience strongly, the balance would have been redressed to some extent. It was noted in Sandside that there was a greater willingness to consider resilience as flooding was sufficiently frequent for the merits to be recognised. See Table A5 below for a comparison of resistance and resilience measures.

Table A5 Resilience versus Resistance Measures

Resilience measures	Resistance measures
Suitable for all property types	More suitable for detached or semi-detached properties
More expensive	Relatively less expensive
Timing of installation is important (eg. Before moving in, or after a flooding incident)	Can be installed any time
Only cost-beneficial where risk of flooding is high (greater than 4%)	Provides limited protection up to a given height.
More preferable for flash floods, for less physically able people or those away from home for long periods	Measures (eg. Door boards) have to be physically deployed at the time of flooding eg. Door boards
Measures are less obtrusive	Measures are more obtrusive

Other main findings

There was no detailed analysis of costs and benefits of the individual pilots. The focus of the pilots was on improving understanding of the grant distribution/implementation mechanisms. The results from the pilots were not completed in time to feed into the work done by Entec on the economic assessment. However, most of the homes involved in the pilots were in areas of a 10% or above annual chance of flooding, suggesting that the temporary protection measures employed in the pilot would be cost beneficial in the Entec model (Table A6). Table A6 shows that when deployed consistently and correctly, temporary resistance measures are economically worthwhile for properties with an annual chance of flooding of 2% or above (a 1 in 50 year return period). Resilience measures are less cost-effective than resistance measures. However, when a building is in need of repair or refurbishment following a flood, the extra cost of a resilient repair will be relatively low. This is reflected in the improved resilient repair benefit-cost values shown in Tables A6. However, these values are still relatively lower than for resistance measures due to higher upfront installation costs for resilience measures.

Table A6 Economic benefit-cost ratios for different packages of flood resistance and resilience measures, including resilient repair – residential properties

		Resistance Measures		Resilience Measures		Resilient Repair	
Annual chance of flooding	Return frequency (years)	Temporary	Permanent	Without resilient flooring	With resilient flooring	Without resilient flooring	With resilient flooring
20%	5	10.6	8.4	3.7	3.7	6.7	5.5
10%	10	5.8	4.3	2.1	2.0	3.9	3.0
4%	25	2.6	1.8	1.0	0.9	1.9	1.4
2%	50	1.3	0.9	0.6	0.5	1.0	0.7
1%	100	0.3	0.2	0.1	0.1	0.2	0.2

Source: Entec *et al* (2008)

In-depth interviews with some beneficiaries of the Leeds and Nottinghamshire pilot programmes suggested that in some cases people, who previously could not obtain insurance, were able to get insurance after the measures had been installed. This also suggests that the threat of the withdrawal of insurance can be an effective incentive for convincing policy holders to install new protection and resilience measures. Offering better insurance premiums to existing policyholders is likely to be a weaker incentive to invest in resilience measures, as they would still be able to get insurance albeit at higher premiums.

According to confirmed reports, there were a few cases where householders had an increase of insurance premium after the installation of the flood protection products, although this was expected to be contested. The company concerned apparently claimed that the original risk had been misrepresented by the householder, which seems to suggest that some insurance companies are not setting premiums based on their own assessment of risk.

In some cases, property owners were willing to bear some of the costs themselves (Uckfield pilot).

In Bleasby, the interest of those surveyed in resilience solutions had increased to about 25% from less than 10%, but the local view was that there needed to be an external catalyst to escalate interest to action.

In Sands, Appleby, some 10% of the beneficiaries only installed works up to the grant amount, wishing to complete the remaining works when funding was available. This in some cases led to partial protection of the property, which was still exposed to the risk of flooding.

Even with full funding, some pilots reported that people were declining to participate because of concerns over potential loss of property value if visible flood resistance measures were installed (local estate agents expressed this view). Some households also declined because of aesthetic concerns.

Lessons and barriers

Results of the pilot scheme and consultation with DEFRA identified a number of lessons and barriers:

- Getting the whole community on board is essential. This makes the measures less stigmatising. It also makes residents feel that they are taking less of a risk by participating in the scheme. A number of pilots seem to have been successful in this respect.
- In some areas, take-up was hampered by the fact that only one product was on offer (e.g. one design of door-board) or products were not kitemarked[91]. Residents in houses of a non-standard design sometimes rejected these, because they felt they would damage the aesthetic integrity of their homes.
- Some residents doubted the effectiveness of the protection measures and only accepted them because they were absolutely free.
- Protective measures that were more visible (use of bright colours and measures that stood out) caused more hesitation. To increase take-up, protective measures would have to be unobtrusive.
- Community engagement took up significant resources, particularly where local opinions were strong. In hindsight, the programme time-table should have been

[91] PAS 1188 Kitemark flood products that protect doorways, low silled windows and airbricks.

longer, around two years instead of one year. This would have allowed more lead time for community engagement, detailed surveys and selection of options.

- Quality control was a concern particularly if property owners (generally considered as ill-informed clients on engineering matters) were left to procure solutions themselves.
- Economies of scale can be achieved with centralised procurement managed by qualified engineers at the cost of less choice.
- Available of skilled contractors was an issue and further increased risks of using ‘cowboy’ contractors.
- Currently there is no national guidance on concerns over structural safety and impacts on ventilation (gas safety) arising from resistance solutions.
- It is important that there is sufficient capacity in the survey industry to deal with the increased demand for advice that a grant scheme might bring; and there was a need to ensure adequate capacity within the flood products industry to deliver quality solutions for any grant scheme.
- Overall, the uptake and willingness to bear some of the costs depended on widely different social perceptions regarding flood protection and the local view on fairness. Some were confident that the measures will make a difference and were happy to share the costs. For example, households in the Leeds pilot were able to appreciate the benefits of the protection measures as it was exposed to flooding soon after installation of the measures. On the other hand there were a number of reasons for households to ignore the information and not be willing to share some of the costs. The main reasons were:
  - Low perceived chance of flooding
  - High cost
  - Doubts on effectiveness of the protection measures
  - Negative impacts on property values – partly compounded by advice from estate agents
  - Feeling that protection should be provided by community defences

Overall assessment

Overall, this pilot was successful in terms of achieving take-up of household flood resistance measures and provides evidence for improving this performance e.g. through ensuring that the range of quality resistance measures are able to better meet household aesthetic concerns. However, it also showed that this type of grant scheme did not effectively promote resilience measures. DEFRA has considered the possibility of compulsory resilient repair after flooding. The pilot however, does not provide particular evidence on the optimum funding model for a grant programme.

Calgary Water Meter Installation Programme (WMIP)

Context and objectives

Aim: The main aim was to remove the financial risk that prevented many Calgarians from switching to metered water rates.

The WMIP (1991-2001) was designed to counteract the strong local opposition towards water based charging. Under the programme, the City would compensate homeowners should using a meter prove more expensive in the first year than the previous fixed rate.

Context: Historically there has been a strong opposition towards metering in Calgary. Consumer choice, affordability, increased expenses, equity, and anti government sentiment were all strong motivations against the introduction of water metering. Public opinion on water metering was quite divisive. Some perceived it is a fair and balanced approach while others saw it as a way for The City to collect more taxes from the public.

On the other hand, there has been an increase of 160,000 people living in Calgary, and it is expected there will be a 2–3% population growth rate per year until the year 2012. This led to an increase in total demand for clean, safe drinking water. Without conservation measures, the City demand is forecasted to exceed its maximum allowable withdrawal limit by 2030.

Economic driver: The main economic diver for universal metering from the City of Calgary's point of view was the need to maintain its levels of economic and population growth within the context of a fixed water resource. Calgary Waterworks had a licence to withdraw a total of 337,049 mega litres of water from the Bow and Elbow rivers annually.[92] The majority (82%) of the water is drawn from the Elbow River. Increasing the withdrawal capacity would have required investment in a new treatment plant.

The installation of meters also allowed Calgary Waterworks to better monitor its system for leaks and to more accurately project future demand.

The WMIP programme was also based on research "Towards Sustainability: Municipal Infrastructure and Water Efficiency" conducted by the Federation of Canadian Municipalities in 1999. Economic, environmental and social benefits of metering were calculated in this report.

Environmental driver: The Bow and Elbow River watershed faced increasing pressure due to population growth in Calgary and increased demand from other municipal, recreational, industrial and agricultural users, both upstream and downstream. The continued growth in both residential and general service customers has led to an increase in average day demand. In 1991, average day demand was 424 megalitres, 46% of the maximum allowable withdrawal. By 1999, average day demand was 455 megalitres per day or 49% of the City's allowable water supply[93,94]. According to a report by Canadian Energy Research Institute[95] for the City of Calgary, measures such as metering were necessary for ensuring Calgary's water use patterns were sustainable in the long-term.

Inputs, activities and outputs

The City of Calgary administered the programme through its waterworks department. Under the programme, the City would compensate homeowners should using a meter prove more

[92] Annual Review of WIMP programme 2001

[93] 2001 Feb 7 OE report

[94] Annual Review of WIMP programme 2001

[95] Potential Effects of Climate Change on the City of Calgary: Adapting to a New Environment, Canadian Energy Research Institute, December 2005.

expensive in the first year. The programme was funded solely by the City of Calgary. Meters were always available free of charge to the public. Each meter cost CAN$250 to install and was installed by the Water Services.

Outcomes and Impacts

Take up

In 1991, 22% of the 267,216 households in Calgary were metered. By 2001, a total of 56% of the City's 878,866 households were metered. This compares to English averages of about 5% metered in 1991 and 20% in 2001[96].

Between 1991 and 2001, 430,700 households were metered. The households most likely to take part in the WIMP programme were characterised by smaller household size, smaller landscapes and home ownership.

The average household saved CAN$240 per year through participating in the WIMP Programme. Only a small proportion of metered customers, 8%, saved less than CAN$50 per annum[97].

A City of Calgary survey in 2001 found that that 95% of the residential customers who tried a water meter for one year were so satisfied that they decided to keep the meters[98]. Over all 95% of consumers who made the switch to metered billing saved money, therefore the cost of compensating high volume consumers was minimal.

The drop in revenue to Calgary Waterworks from residential customers switching to a meter was offset by the increase in new residential accounts over the course of the programme.

Environmental impacts

In 2001, average daily water consumption was 1.5 times greater for non-metered households (381 litres vs. 255l itres per capita per day) [99].

Increased water metering may also have helped to reduce Calgary's peak day demand (the highest demand experienced in the year) over the course of the programme. Despite similar summers in 1987 and 2001, peak day demand was 33% less in the latter year (955 vs. 1,435 litres per capita). This reduction was in large part attributed to the higher rates of metering in 2001. It is estimated that if Calgary were 100 percent metered, peak day demand for 2001 would be 721 litres per capita, a further reduction of 25 percent.

However customer research indicated that regardless of whether customers were on a flat rate or metered, most believed they were only using the water that "they needed". Metered households did use substantially less water but it is difficult to ascertain from the available data whether or not this difference in consumption was due to a change in behaviour in metered households or a preference for higher consuming households to remain on flat rate billing. In general, according to the research, metered customers were more likely to take responsibility for their water use. The research also indicated that only a relatively small portion of flat rate customers were responsible for the higher trends in water use for the entire flat rate customer group.

Reduction in water consumption in addition to the implementation of a water-metering regime was also attributed to a number of public awareness activities.

[96] Defra, 2008, Future Water: the Government's Water Strategy for England - www.defra.gov.uk

[97] (CALGARY WATERWORKS, 2002)

[98] (Anon, 2001)

[99] (CALGARY WATERWORKS, 2002)

The cost benefit ratio was not explicitly calculated for this programme, but in essence the costs of the incentive, the guarantee of no cost increase, was not significant as it was hardly claimed. This means cost benefit would be the same as for normal voluntary metering programmes.

CO_2 savings were not calculated for the WMIP Programme.

Lessons and barriers

The WMIP programme was intended to have a "zero net impact" on the city's demand for fresh water i.e. reductions from metering equalled increased demand from population growth. Although overall demand did reduce, it was not sufficient to entirely compensate for the City's population growth.

Although the voluntary switch to meters was successful during the initial years of the programme, the rate of switching customers on a voluntary programme began to decrease towards the end of the programme. New approaches, such as the free showerhead pilot project, were implemented to maintain the conversion rate towards the end of the programme[100]. By 2001 consumer research suggested that the majority of the households in Calgary that were in favour of metering had had one installed. This suggested the need to move to compulsory metering.

The WMIP programme had high installation costs, and it was difficult to administer initially due to the strong opposition.

A small portion of Calgary properties would not be eligible for the WMIP programme as the properties lacked an indoor space where they could be installed. Due to the climatic conditions in the City of Calgary, the meters had to be installed in a basement to prevent them from freezing.

The meters had a limited lifespan of 10 years before they require upgrading.

Next steps

From March 2002, it was made compulsory for all homes to have a meter installed before 31 December 2014. After, compulsory metering was introduced overall metering penetration for residential consumer increased from 58% in 2002 to 81% in 2007. This was slightly below the target level of 82% by 2007. Compulsory meters now have to be installed when a home is sold or constructed. By 2007, all industrial, commercial and institutional customers were metered.

Overall assessment

It would seem from this case study that the incentive scheme had a real impact on the take-up of meters as the level of metering increased at about twice the rate as in England over the same period. Although the vast majority of those that took up meters made substantial cost savings anyway as they were low water users, it would seem that providing a guarantee that they wouldn't lose, had a significant effect.

It is less clear how far metering affected water use as the market research suggests that changes in water use behaviour were not significant. However there did seem to be overall reductions in water use, which could be partially attributable to metering, which in England has been shown to lead to about a 10% reduction in water use[101].

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[100] (CALGARY WATERWORKS, 2002)

[101] Defra, 2008, Future Water: the Government's Water Strategy for England - www.defra.gov.uk

The fact that Calgary moved to compulsory metering suggests that this incentive has limitations and will only work for those who are likely to gain from metering.

Relevance to London and the UK

According to their draft 5 year plan 2010-15[102], Thames Water intends to increase the amount of properties metered from 27% in 2010 to 54% by 2015 with a view to achieving 100% metering by 2020. To do this, they expect to fit about 1m meters of which over 90% will be fitted compulsorily or in new properties. They intend to adopt a progressive targeted programme of compulsory metering focussing initially on areas where pressure on water is greatest including London. Within those areas they will target properties with greatest potential savings (e.g with gardens) and avoid areas where they could be affordability issues.

Given that Thames Water is currently planning to rely heavily on a compulsory approach to metering, the use of incentives for voluntary metering may not be relevant in the long term. Such an incentive scheme could also create tensions as in effect those voluntarily taking a meter would be treated better than those forced to have a meter. Also, if Thames Water's plan to use compulsory metering is not approved, then the use of this type of incentive could be highly relevant to accelerating the uptake of voluntary metering.

[102] Thames Water, 2008, Draft Five Year Plan 2010-15 - http://www.thameswater.co.uk/cps/rde/xchg/SID-15181A39-3B7F5368/corp/hs.xsl/6915.htm

The National Flood Insurance programme (NFIP), USA

Context and objectives

Aim: There are two main aims of the National Flood Insurance Programme (NFIP):

- to protect communities from potential flood damage and
- to provide people with flood insurance where they have been unable to obtain insurance from insurance companies

Context: The Programme was established in 1968 by the US Congress. The programme was amended significantly in 1969, 1973, and 1994. Prior to 1968 flood insurance was virtually non-available from the private sector. Over the past 40 years, a handful of private insurance providers have begun to provide flood insurance. However, the vast majority of home and content insurance packages sold in the US still do not include flooding insurance. The NFIP also provides flood insurance to households that would otherwise be uninsurable through

- previously experiencing flooding;
- being built in high-risk areas; or
- receiving Federal disaster assistance loans.

Inputs, activities and outputs

The NFIP is currently run by the Mitigation Directorate, a component of the Federal Emergency Management Agency (FEMA). However, the policies are sold through private insurance companies. Claims and programme operating expenses are funded through annual flood insurance premiums, rather than public tax dollars. From 1991, a fee of US $30 has been applied to most policies in order to generate the funds for salaries, expenses, and mitigation costs.

The NFIP provides homeowners, tenants and businesses with comprehensive flood insurance. Residential homeowners are eligible for up to US$250,000 in building coverage. Additionally, homeowners and tenants are eligible for up to US$100,000 of contents coverage. The insurance provided to households though the NFIP has significantly lower premiums (US$400 per year) than comparable private insurance plans (A.M. Best Company, Inc., 2006).

All homeowners and Tenants who do not live in a Coastal Barrier Resources Systems (CBRS), such as oceanfront land or the Great Lakes are potentially eligible for flood insurance. The CBRS are excluded in an effort to prevent degradation to buffer areas that protect properties on land from serious flood damage. However, properties in CBRS built prior to 1982 are still eligible for NFIB insurance.

NFIP insurance has been mandatory for properties in flood prone areas where the purchaser sought either a mortgage from a federally regulated lending institution or federal assistance (Wilkinson, 2005). Coverage is also mandatory in order for households that have received federal disaster assistance for flooding to remain eligible for such assistance in the future.

However communities in flood prone areas need to meet the certain requirements for households in those areas to be eligible for insurance, including:

- Mapping Special Flood Hazard Areas that would have a 1% chance of being flooded - “a base flood.”
- Ensuring that new and substantially improved residential structures are above the base flood level or are have resistance measures in place

- Prohibiting development in floodways, (the central portion of a river floodplain needed to carry deeper and faster moving water)
- Implementing additional requirements to protect buildings in coastal areas from the impacts of waves, high velocity, and storm surge

Funding for communities to implement the above hazard mitigation measures is available through separate federal programmes such as the Federal Hazard Mitigation Grant Program (HMGP)[103] and the Pre-Disaster Mitigation Grant Program (PDM)[104].

Outcomes and Impacts

Insurance take-up

As of 2006, the programme has nearly 4.6 million policies in force nationally, representing approximately $746 billion of flood insurance in force (Collins Center for Public, 2008). The programme insures 49% single-family homes located in high-risk flood zones across the US. Additionally, 20,000 communities across the US voluntarily participate by adopting and enforcing floodplain management standards.

Economic impacts

See Table A7 for key statistics for NFIP.

Table A7: Annualised statistics for the NFIP[105]

Year	Policies in force (million)	Losses paid out ($m)	No. of claims	Claims as a % of Total Policies
1980	2.1	23	41,900	2%
1990	2.5	168	14,800	1%
1995	3.5	1,296	62,400	2%
2000	4.4	252	16,400	0.4%
2004	4.7	2,214	55,700	1%
2005	**5.0**	**17,575**	**210,900**	**4%**
2007	5.7	523	21,300	0.4%

Since the 1990's, there has been a steady increase in the number of policies in force. As of 2007, there were 2.7 times more households insured through the NFIP than in 1980. Although the number of claims has increased since the 1980's, the percentage of policyholders that claim has remained stable over the past 27 years. However, the number of claims that the NFIP pays out annually, fluctuates based on the severity of the hurricane season. When Tropical storm Alison hit in 2001, the number of claims made doubled. In 2005, Hurricane Katrina caused an abnormally high spike in the percentage of policies that claimed (4%) over the previous year (1%).

[103] Hhttp://www.fema.gov/government/grant/hmgp/H

[104] Hhttp://www.fema.gov/government/grant/pdm/index.shtmH

[105] http://www.fema.gov/business/nfip/statistics/statscal.shtm

The average cost of a flood claim in 2004 was $32,056, and the average flood insurance premium was $438 (Wilkinson, 2005).

At a household level, the flood insurance component of the NFIP is designed to provide an alternative to disaster assistance and to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. The cost of repairing the damage caused by 1 inch (2.5cm) of floodwater is estimated at a minimum of US$7,800, while 18 inches (45cm) of floodwater would cost a minimum of US$26,300[106]. In communities that have enacted NFIP mitigation measures, this type of property damage is up to 80% less.

Less than half of the flooding events that occur in the US are severe enough to cause a community to be declared a federal disaster area. The household NFIP premiums have been priced to be less than the cost of repaying a federal disaster assistance loans.

At a community level, the mitigation measures required by the NFIP reduce the vulnerability of residents to damages caused by pluvial and fluvial flooding. The NFIP estimated that annual flood damage is reduced by nearly $1 billion a year through communities implementing sound floodplain management requirements, and required building standards as well as property owners purchasing flood insurance. A recent study by the Multihazard Mitigation Council has shown that each dollar spent on mitigation measures saves four dollars on average in damage repair and temporary relocation costs[107].

Lessons and barriers

At a household level, market penetration of flood insurance has been low, in spite of mandatory purchase requirements for new construction and the availability of subsidized insurance rates for older buildings located in flood-hazard areas (Burby, 2001). An analysis of the uptake of insurance through the NFIP from 1983 to 1993, found that flood insurance purchases at the state level were highly correlated with the level of flood losses in the state during the prior year (Hoyt, 2000).

There are a number of other issues with regards to the NFIP programme:

- The majority of surveyed homebuyers in flood hazard areas did not fully understand the level of flood risk or the cost of insuring against this risk when negotiating the purchase of their property. This survey also found that income and price were highly influential factors in household decisions to purchase flood insurance (James Chivers, 2002).
- The low maximum coverage limits, and the lack of coverage for additional living expenses, reduced the financial incentives for households and communities to participate in the programme (A.M. Best Company, Inc., 2006).
- The NFIP has experienced repetitive claims suggesting flood prevention and mapping has not been effective. Less than 2% of properties generate nearly 40% of NFIP claims. In all, 15,275 (20%) repetitive loss properties were located outside the designated 100-year floodplain. This finding cast doubt as to the accuracy and reliability of NFIP maps (Conrad, 2006).

Overall assessment

This programme arose to meet a market failure in that flooding insurance was not supplied by the market. Given that, it has been successful in that 49% of households with a high risk of flooding are insured when previously none would have been. However this compares to

[106] Hhttp://www.floodsmart.gov/floodsmart/pages/flood_policies/the_cost_of_flooding.jspH

[107] Hhttp://www.fema.gov/hazard/midwestfloods.shtm#2H

the UK where flood insurance is a standard part of household building insurance, which is required by mortgage companies and hence coverage is near universal.

Relevance to London and the UK

The UK model for the provision of flood insurance is based on a national agreement between the UK government and the private insurance industry. This agreement is broadly that the insurance industry will continue to provide flood insurance dependant on government policies to improve flood defences and to reduce the risk of flooding in other ways, for instance through better planning for new property developments. While this agreement stands and private insurance is available, there is no case for a public funded insurance system similar to NFIP.

There may be potential for the insurance industry to learn from NFIP at a local level in terms of setting requirements for continued insurance in high flood risk areas. For instance, insurance companies could require flood resistance and resilience measures to be fitted to recently flooded buildings for insurance to continue to be available or vary insurance provisions based on whether properties have resistance and resilience measures. This is similar to the situation in Florida, where insurance companies have to provide a discount where properties have reduced risks of damages from windstorms[108]. Currently insurance cover usually pays to put a flood damaged house back into its original state rather than funding measures to ensure it is more resistant and resilient to flood damage in the future. This would be consistent with the recent joint ABI/Defra statement recommendation to 'encourage actions to mitigate and minimise the risks and costs of being flooded'[109].

[108] R. Ward, C Herweijer, N Patmore and R Muir-Wood, 2008, The Role of Insurers in Promoting Adaptation to Impacts of Climate Change, The Geneva Papers 33, pp133-139, The International Association for the Study of Insurance Economics, Hwww.palgrave-journals.com/gppH

[109] ABI/Government Statement on Flooding and Insurance for England, July 2008, www.defra.gov.uk