STERN Review Economics of Climate Change

GLA Response to Discussion paper

Introduction

Cities account for some 75% of the world's energy consumption and 80% of greenhouse gas emissions. However, cities are equally fundamental to global GDP. Ten of the world global cities in terms of economic strength generate some 20% of the world's GDP with only 2% of the earth's population[1].

The increasingly urban nature of human settlement (almost 50 per cent of the world's population lived in cities in 2003 and this is predicted to rise to 60 per cent by 2030) means that the impact of climate change on cities will become even more important. Cities would need to recognise that action needs to be taken in respect of the environmental impacts of economic growth in particular with climate change. Cities consume large amounts of energy and thus create a significant amount of emissions. The high density of population further means that the negative impact on health due to poor air quality is quite high. On the other hand, high density of population and economic activity also means that there are greater opportunities to take advantage of opportunities such as new energy systems, modern public transportation methods and renewable energy.

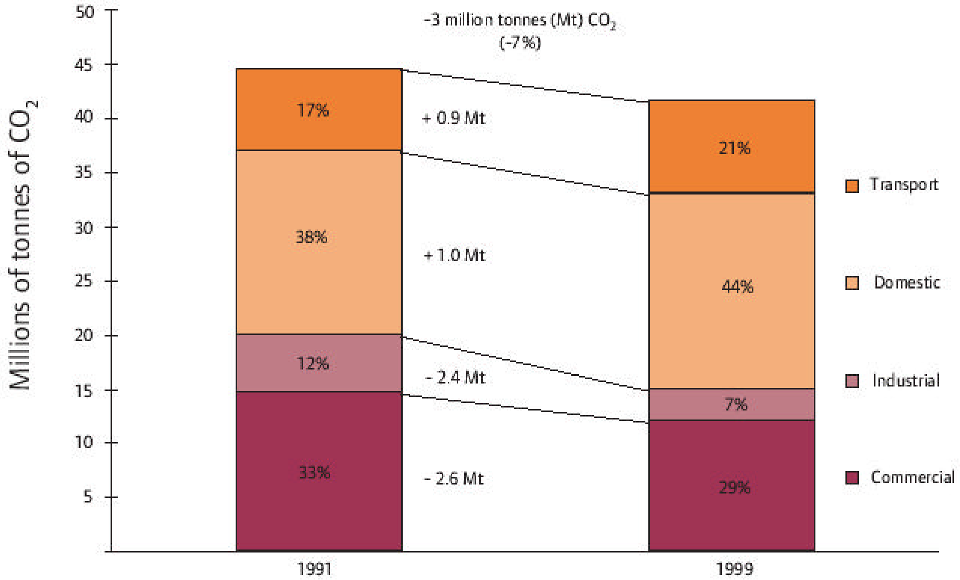
1. London's Economic and emission growth

London's economy is characterised by a preponderance of business and financial services (banks, pensions and insurance, legal activities, accounting, management and marketing) and shift away from traditional manufacturing jobs. As a result, jobs in the financial and business services sector have doubled as a proportion of all jobs between 1971 and 2003, from around 730,000 to around 1.4million jobs – or nearly one in three of London's jobs. During the same period manufacturing jobs fell from around 27 per cent of jobs to around 6 per cent, or from 1.3 million to around 270,000 jobs. In section 2.3 we discuss the potential impact of climate change on the financial sector.

As shown in figure 1, emissions from transport increased, while those from commerce and industry fell - dramatically in the case of industry, as a result of both decreased activity and the reduced carbon intensity of electricity. Domestic emissions increased, despite the changes to the fuel mix for electricity generation, because overall energy consumption in this sector increased significantly.

[1] http://www.ucl.ac.uk/environment-institute/workshop_climate_change.pdf

Figure 1. Emission projections by sector



Source: Mayor's Energy Strategy: Green light to clean power, GLA, Feb 2004

New housing growth is based on 31,090 dwellings per year from 2007 onwards following the London Plan requirements. The London Housing Strategy currently envisages the completion of 35,400 units per year to 2016. The energy and emissions implications of housing (35,400 per year till 2016) expansion of different policy scenarios currently being assessed in a study by the London Climate Change Agency (LCCA) is discussed later.

2. Main impacts of Climate Change on London

2.1 Urban heat island effect

The urban heat island effect in London affects health, buildings and biodiversity. Air quality worsens under certain conditions, such as still, sunny days in summer. Projected increases in dry, sunny weather in summer due to climate change will therefore favour the production of more air pollutants. Any decline in air quality could pose serious health risks for asthmatics as well as causing damage to London's plants and buildings. Commercial, public and domestic buildings are responsible for seventy per cent of London's carbon dioxide (CO2) emissions. London's housing stock is relatively older than the rest of UK with the most deprived living in unfit homes or accommodation not meeting decent homes standards. Climate change would thus negatively affect most social deprivation indicators in London.

2.2 Impact on transport

From 1992 to 2003, over 1200 flooding incidents and 200 station closures were recorded by London Underground Limited. Flooding of the London Underground between September 1999 and March 2004 has cost approximately £14.6 million in passenger delays alone, with the flooding of 7 August 2002 costing approximately £0.74 million[2]. Frequent and extreme change in temperatures lead to infrastructure damage such as track buckling, carriageway rutting, embankment subsidence,

[2] http://www.london.gov.uk/climatechangepartnership/docs/climatetransportsept05.pdf

deterioration of concrete, problems with expansion joints, increase in dust levels and reduction in skid resistance.
There are more delays for rail travel in hotter temperatures. In the hot summer of 2003 there were 165,000 delay minutes nationally (compared with just 30,000 in the cooler summer of 2004). The number of buckled rails (approximately 130) was also high and consistent with other hot years (1976 and 1995). The economic cost of the delays in 2003 in four of the railway sectors around London was at least £0.75 million. The costs of repair are unknown.

2.3 Impact on Financial sector

Gross insurance premiums on the London Market were conservatively estimated at £21.7bn in 2004 down 15 per cent from the £25 billion in 2003. London's market share of world industrial insurance is between 10% and 15%. London is also the largest centre of protection & indeminity (P&I) insurance, with P&I Clubs operating in the UK accounting for 67% of the global market in 2004. In 2003, insurance corporations and pension funds accounted for approximately 2.3% of UK GDP, up from 2.0% in 2002.

Weather events lead to business disruption, which in recent times has accounted for a significant proportion of insurance claims. Lloyd's of London's provisional estimate for the claims arising from Hurricane Katrina is around £1.4 billion. Climate change risks, through the insurance sector can lead to further implications in the financial market affecting investment decisions and pensions funds. Severe weather events lead to large insurance payouts, which reduce insurers' and reinsurers' capital reserves if provisions were not previously made. As risks increase, more businesses my need to increase cover leading to more business for insurance companies.

As London has grown, the economic centres have moved to areas more susceptible to storm surges and flooding, such as Canary Wharf/Isle of Dogs. London's climate change risk is high due to high concentration of high value assets (human and physical capital). According to a report by Munich Re. London is in the top ten megacites exposed to weather related risks[3].

London's economy is based on the City, and London is in constant competition as the premier financial centre in the EU time zone. If London fails to become a "green" i.e. low emission city, then sooner or later the risk is that companies will not want to locate there. The issue is similar to other bottlenecks such as crime, congestion and high housing costs. The risk may currently appear low, in relation to London's attractions, but it is already rising up the political agenda.

3. Economics of mitigation measures

Measures to reduce CO_2 emissions and increase energy efficiency should be cost effective. Cost effectiveness implies achieving a given CO_2 target at lowest cost or alternatively, for a given cost, achieves the maximum CO_2 reduction. Cost effective analysis is used when measurement of benefits in monetary terms is impossible, or the information required is difficult to determine or in any other case when any attempt to make a precise monetary measurement of benefits would be tricky or open to considerable dispute. In this case the benefits of CO_2 reduction in monetary terms is

[3] http://www.munichre.com/publications/302-04271_en.pdf?rdm=73899

subject to debate, though DEFRA has suggested a figure of £70 per tonne of CO_2 as the social cost of carbon. However, monetary benefits such as reduced energy bills and reduced cost of energy generation can be more easily quantified.

A mix of demand based measures in the short run, such as energy efficiency measures, and supply based measures, such as renewable forms of energy would be required to achieve a cost-effective solution. Capitalising the cost of implementing both measures in terms of net present value (NPV) to achieve any CO_2 target would allow comparison or choosing the right combination of measure. In order to do this a number of factors have to be taken into consideration, such as: capital cost of measures, rate of return, amortisation period, discount rate, construction period, potential or scale of measures, other costs, market risk, availability and economic viability of substitutes and damage cost of carbon.

3.1 Housing

New housing growth is based on 31,090 dwellings per year from 2007 onwards following the London Plan requirements. These new dwellings in addition to the existing stock have varied levels of potential for improvement in energy efficiency.

Box 1

Existing stock measures	**New homes measures**[4]
Cavity wall insulation, Loft insulation, Low emissivity double glazing, reduced flow hot-water fittings, Low energy light fittings, Condensing boiler, Reduced Infiltration (draft proofing	Reduced U-values[5] by 30-60%, solar gain 4:1 south facing windows, reduced flow hot-water fittings, condensing boiler, reduced infiltration with mechanical heat recovery, solar Water Heater, photovoltaics, micro wind, ground-source heat pump. Additional renewable energy stand-alone technologies fulfilling the Mayors Energy Strategy include: Small wind turbines, Photovoltaics and Large wind turbines.

The energy and emissions implications of housing expansion of different policy scenarios assessed in a study by the London Climate Change Agency (LCCA) concludes:

- Larger fuel savings, in terms of net change in gas and electricity consumption for each measure, are possible by using low-carbon measures on older dwellings[6].
- Renewable electricity and CHP give the largest CO_2 reduction by displacing grid electricity.
- Cost neutral carbon savings are more easily achievable in older dwellings[7].
- The potential for CO_2 reduction in new build is small due to the good thermal performance of buildings.

[4] The new homes measures are in excess of those required in the 2006 new Part L building regulations
[5] Measure of heat loss through walls
[6] See Annex for details.
[7] See Annex for details.

- Constructional improvements to reduce infiltration and recovery of heat with a mechanical heat recovery unit give the biggest reduction in space heating demand.
- Micro wind turbines (rooftop) provide the largest offset of CO_2 per house with a reduction of over 1 tonne. They are also one of the most economic measures (approx. £0.25 per tonne CO_2 saved) and expected reductions in capital costs (see Annex) will improve their viability even further.

Projections till 2025 on CO_2 savings, fuel savings and cost savings for two options[8] using the measures mentioned in Box 1 were undertaken for both existing and new build homes in London.

Box 2 Capital cost, fuel cost and CO_2 savings

	Option 1				
Year	CO2 saving per year (1000 tonnes CO2)	Savings in fuel cost (£ millions)	Capital investment (£ million annually)	external cost of CO2 (£ million)	Total benefit (£ million)
2010	685.3	133	590	13.082377	146.0824
2016	1090.2	213	208	20.811918	233.8119
2025	1470.5	287	187	28.071845	315.0718

	Option 2				
Year	CO2 saving per year (1000 tonnes CO2)	Savings in fuel cost (£ millions)	Capital investment (£ million annually)	external cost of CO2 (£ million)	Total benefit (£ million)
2010	685.2	129	620	13.080468	142.0805
2016	1089.9	204	229	20.806191	224.8062
2025	1469.7	270	204	28.056573	298.0566

Note: Total benefit is calculated by adding savings in fuel cost and external cost avoided by CO_2 reductions. External cost of carbon of £70/tonne of carbon equates to £19.09 per tonne of CO_2.
Source: London Climate Change Agency

The above table shows that capital investments for CO_2 emissions are high in the initial period till 2010. However, from 2016 onwards the savings in fuel cost out weigh the capital investment. The total benefit increases if we include the external cost of CO_2 emissions avoided as a result of the measures mentioned in box 1. The external cost of CO_2 is calculated by using the DEFRA figure of £70 per tonne of carbon.

3.1.1 Economic incentives for sustainable energy installation in homes

Public policy has always used grants, tax discounts and subsidies as incentives for the uptake of desired goods or services. These fiscal incentives are used for three main reasons:

1. To subsidise the supply of certain goods and services.

[8] Option 1 - involves enhanced thermal improvements to both existing private and social housing and community boiler replacement with CHP. No new housing is electrically heated and ALL new developments (which were designed for gas heating) use community CHP (100% CHP).
Option 2 - involves enhanced thermal improvements to both existing private and social housing and community boiler replacement with CHP. 33% of new housing (the realistic maximum) receives community CHP, 50% of new build (houses not receiving CHP) have extensive RUE and the renewable targets for PV, microwind, and solar water heating are achieved.

2. To compensate for differences in income levels and consequently public services.
3. To provide a minimum service or spending levels for different goods and services.

Fiscal incentives can be used to promote energy efficiency in homes, environment friendly cars and certain vocations. Policy makers in principal aim to tax the 'bad' and subsidise the 'good'.

Fiscal incentives for energy efficiency are needed partly because energy suppliers structure prices to encourage higher use – most use a two band pricing structure with a high unit charge for initial units, then a lower unit charge for subsequent units. Under the deregulated energy market, this is of course is logical for companies trying to sell as much energy as possible.

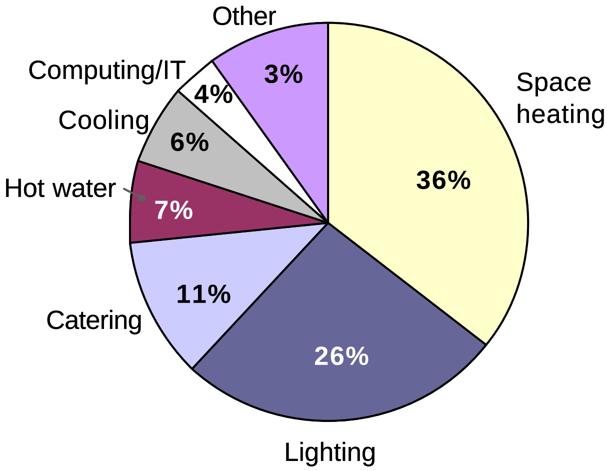
A number of fiscal levers and policies have been suggested to assist domestic energy efficiency in response to the Treasury Consultation Document '*Economic instruments to improve household energy efficiency*'[9].

- Only 5% VAT on the supply and installation of insulation materials under Government grant schemes and non-grant schemes when householders employ contractors.
- Only 5% VAT on DIY energy saving materials, bought by households.
- Grant subsidy to households installing innovative products such as, micro CHP and heat pumps to encourage uptake of new technology.
- Enhance and extend existing capital allowances to allow companies' investments in all domestic energy saving equipment to be written off against tax in a single year. This would again act as an incentive for take up.
- Council tax reduction (over 3-5 years) for specified and approved increase in SAP ratings[10]. Would include immediate rebate for cost of verification survey.
- Tax incentives to help energy efficiency companies expand by providing:
    a) tax allowance for companies training installers. This could help alleviate shortages in desired workers (eg. Solar water heater installers).
    b) tax incentives for investors in energy efficiency companies (similar to the Enterprise Investment Scheme). This would help companies raise the necessary capital to expand and develop new innovative products (such as micro CHP).

3.2 Commercial

The commercial sector in London is responsible for around 30 per cent of all CO_2 emissions. Space and water heating are responsible for almost three-quarters of these emissions.

[9] http://www.london.gov.uk/assembly/envmtgs/2003/jan14/envjan14item08_cd.pdf
[10] SAP ratings assess the energy efficiency of dwellings by calculating the energy cost factor (ECF) for each home. SAP ratings are scored on a scale from 1 to 120 where 1 is the worst and 120 the best.



Source: National Statistics: Service sector energy consumption, 2001 (original source: Building Research Establishment)

Moving towards best practice provides the opportunity to reduce CO2 emissions per m^2 by between 20 and 40% per year. Retail offers significant long-term opportunities due to its high levels of electricity consumption. Best practice in retail can reduce CO_2 emissions from 222 kgs per m^2 per year to 123, which is a substantial 44% reduction[11].

3.3 Transport

Transport accounts for about 20 per cent of London's CO_2 emissions. Road transport accounts for more than 80 per cent of all transport-related CO_2 emissions. As mentioned before substantial emission reduction is possible by behavioural change, soft transport demand management (TDM) and shifting to new technology such as hybrid and hydrogen fuel cell (HFC) vehicles.

Some options for reducing transport emissions[12]

- Savings of up to 15 per cent CO_2 emissions can be achieved through changing driver behaviour, such as avoiding heavy accelerating and braking.
- Soft TDM measures such as work and school travel planning, promotion of teleworking and video conferencing, support of car sharing and car clubs, together with increasing public awareness of travel alternatives and implications can save a further 5% of CO_2 emissions in 2015 compared to 2005.
- National road user charging scheme as explored recently by DfT could reduce CO_2 emissions by a further 5-10% in London
- Low carbon vehicles such hybrid or HFC emit around 30% and 30-50%[13] less CO_2 emissions compared to internal combustion petrol/diesel vehicles. The private vehicle fleet may be comprised mostly of hybrid and HFC vehicles by 2050[14].

[11] Implications of the London Plan and the London Housing Strategy on CO2 Emissions (draft), report produced by Element Energy for LDA, Jan 2006
[12] TfL Climate change and carbon dioxide emissions transport sector
[13] CO_2 reductions realised from hydrogen fuel cell vehicles are dependent on hydrogen production method.
[14] Future proportions of vehicle types are impossible to predict; however, current evidence suggests that both of these technologies will be commercially viable within the next 10-20 years (diesel hybrids are already available) and prevalent by 2050.

Box 3 Cost savings per year from hybrid or alternative fuel vehicles (2004)

Manufacturer	Vauxhall	Vauxhall	Toyota	Total	Honda
Model	New Astra Sxi	New Astra Sxi	Prius	Corolla	Civic IMA
Engine	1.4i 16v dual fuel	1.4i 16v	1.5 VVT-i	1.6 VVT-i	1.4
Fuel	petrol/lpg	petrol	petrol/electric	petrol	petrol/electric
Price (£) in 2004	15,220	12875	17,500	13,500	14,500
Powershift discount (£)	700		700		700
annual spend petrol @ 89.9 pence per litre (£)	2568[b]	2568[b]	2,697[a]	2,022[b]	2,697[a]
annual spend on alternative (£)	1286 (lpg)		1,231		1,404
annual mileage	20,000	20,000	20,000	20,000	20,000
Savings (£) on fuel	1,282		1,465		1,293
VED band	C	D	B	E	B
VED (£)	95	125	65	150	65
CO2 emissions (g/km)	134	151	104	168	116
Gallons of petrol saved compared to car with average fuel consumption of 30mpg			362		320

[a] Using average fuel consumption for the UK of 30 miles per gallon (MPG)

[b] Using the car's official fuel consumption figures

Source: Vehicle Certification Agency (VCA), Vauxhall, Toyota.

3.4 Low Emission Zone

A London low emission zone would improve the health of Londoners by reducing air pollution related impacts. It would also have small benefits in reducing noise. In later years, it could potentially lead to reduced emissions of the greenhouse gas CO_2. The economic benefits of these environmental improvements would more than offset any costs of introducing and operating the scheme, for example the estimated health benefits in London from the recommended scheme for 2007 are estimated at £100 million. Moreover, these benefits are a sub-total, as they only include the air quality improvements in London - there would also be benefits outside London from cleaner vehicles affected by the London LEZ traveling elsewhere. Overall, the study concludes that the benefits of the schemes are likely to be broadly similar to the overall costs (including the costs to vehicle operators)[15].

GLA Economics are currently working on a report for TfL with Pricewaterhouse Coopers, which focuses on the impact of the proposed LEZ on employment[16] and tourism in London. The impact on employment is measured by using projected costs to vehicle operators, assumptions about their behaviour and their ability to comply. The impact on tourism is estimated by assuming that operators pass on additional costs of complying with the LEZ to passengers. It uses an elasticity of tourism spend to estimate tourism expenditure (and trips) displaced and translates this into an employment impact.

3.5 New forms of energy supply

New forms of energy supply would need to be compared by the same factors as mentioned towards the end of the first paragraph in section 3. It should also be recognised that a shift to renewable, decentralised energy supply or nuclear would still require conventional sources to provide a substantial part of total energy supply.

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[15] http://www.tfl.gov.uk/tfl/low-emission-zone/pdfdocs/phase-2-feasibility-summary.pdf

[16] Looks at employment impacts for the UK as well.

3.5.1 Decentralised

Decentralised energy is that which is connected directly to low voltage local networks rather than the high voltage grid[17]. It includes particularly Combined Heat and Power (CHP), solar PV, fuel cells, small and micro wind, small hydro, biogas, biomass heating, geothermal and local wave and tidal generation. The provisional modelling performed by World Alliance for Decentralised Energy (WADE) on their model of UK power sector shows that fully decentralising new UK power provision is cost-effective. It could lead to a cut of the order of 25% in CO2 emissions, capital costs savings of around £65 billion, and retail cost savings of around 1.5p/kWh.

A recent report[18] for Greenpeace and the Mayor of London demonstrates that decentralised energy generation for London is a viable option for achieving the Government's key goals of CO_2 emission reductions, a secure energy supply, economic growth, and alleviation of fuel poverty – without the need for a new generation of nuclear power stations. Even a low decentralised scenario could reduce CO_2 emissions by around 28 per cent by 2025 on 2005 levels. This reduction would put London on track to achieve the Government's target of a 60% reduction in emissions by 2050.

3.5.2 Renewables

Potential for Wind & Biomass Energy in London

<u>Biomass</u>
Biomass CHP provides one of the most attractive methods of providing low or zero carbon developments in London. Biomass CHP could displace 15% of London's conventional energy needs for buildings, excluding transport, and reduce CO_2 emissions by just over 5 million tonnes per year.

However this would involve using all available biomass whatever its current fate. Assuming that all biomass that is currently not recycled or already used for energy recovery is used, the potential would be to displace around 10% of conventional energy sources, saving around 3.5 million tonnes per year of CO_2 [19]. This would represent electricity generation of around 400MWe maximum. The capital cost would depend on the technology, but taking a rough average of £3m/MWe would give £1.2bn as capital costs plus the cost of the heat network (which we don't have costs for). All of these figures assume that CHP is installed and used for electricity and heat. If CHP were used solely for electricity generation then it would only displace 5% of conventional sources, saving around 1.75 million tonnes per year of CO_2.

Box 4. Potential for CO_2 reduction if all of the biomass resource is utilised

[17] Ofgem defines decentralised energy as plant generating up to 50MW connected to the local distruibution system rather than directly to the high voltage transmission system.
[18] Powering London into the 21st Century, march 2006, report written by PB Power
[19] 3335 ktpa, based on 0.42 grid mix factor and assuming it was CHP

Sector	Material	CO2 Displaced tpa Incineration	Gasification	Digestion
Sewage	Sludge	829	884	32
MSW	Paper/Card	1,457	1,555	0
	Putrescibles	432	460	303
	Misc Combustible	249	265	0
	Wood	144	153	0
Commercial & Industrial Waste	Paper/Card	457	487	0
	Putrescibles	86	92	61
	Wood	38	41	0
	Used cooking oil	95	85	0
	Animal fats	136	122	0
Construction Waste	Wood	45	48	0
Aboricultural	Wood	111	119	0
Woodland	Wood	3	3	0
Farms in GL	Straw	195	208	0
	Vegetable/Cereal Residu	9	9	6
	Manure	0	0	0
SRC Potential in London	Willow	0	0	0
SRC Potential in 40km Radius	Willow	210	224	0
Forestry in 40km radius	Wood	76	81	0
Total		**4,572**	**4,838**	**401**

Source: LEP Wind and Biomass study for Londn

Wind

The wind and biomass study for London identified a number of sites in London with the potential for generating 50Mwe installed capacity for large scale wind turbines. An additional figure was provided through the Energy scenario work for the Green Fund (on behalf of the London Energy Partnership) which identified that micro-wind turbines would generate up to 200Mwe installed capacity.

Box 5. Carbon savings and costs

Systems		Installed Capacity	Heat	Power	CO2 Savings	Capital Cost	Simple Payback	NPV	IRR
			GWh/y	MWh/y	ktpa	£m	yrs	£m	%
Wind - large	MWe	50	0	110	64	29	6.4	25.3	18.8%
Wind - small	MWe	200	0	220	128	315	34.1	-124.6	-6.8%

3.5.3 Nuclear

In 2003, the UK's nuclear generating potential was around 22 per cent of the UK's total electricity generation[20]. However, based on current plans for the installed capacity, by 2020 the nuclear sector's share of total UK electricity generation is likely

[20] *Financing the Nuclear option: modelling the cost of new build*, Oxera, June 2005.

to fall to around 7 per cent (taking into account the estimated 1 per cent annual growth in consumption).

Nuclear has positive externalities (impacts not captured, or borne, by producers or consumers) namely, greenhouse gas emissions are reduced and security of supply may be enhanced. Negatively, there are short and long-term risks of radiation release and also proliferation issues. Valuation of these effects is problematic and only in the case of greenhouse gas emissions saved is useful valuation even likely. Notwithstanding these, the direct costs of nuclear are substantial too.

According to a recent report by the sustainable development commission (SDC)[21], doubling UK's existing nuclear capacity to 20GW would reduce around 13.4 MtC of carbon emissions. This is equal to an 8% reduction from 1990 levels (165.1MtC). On the other hand, the government's Energy Efficiency Innovation Review estimated that energy efficiency in the domestic sector could lead to a potential savings of 9MtC in 2020, and 11.2-12.6MtC in the business and public sectors. They also estimated that fuel switching in the power sector as a result of EUETS could deliver an additional 10MtC as a result of improved end-use efficiency. Even without efficiency gains from fuel switching energy-efficiency can lead to a 20% reduction in CO_2 emissions from 1990 levels.

The SDC report identifies five major disadvantages to nuclear:

1. **Long-term waste –** no long-term solutions are yet available, let alone acceptable to the general public; it is impossible to guarantee safety over the long-term disposal of waste.
2. **Cost** – the economics of nuclear new-build are highly uncertain. There is little, if any, justification for public subsidy, but if estimated costs escalate, there's a clear risk that the taxpayer will be have to pick up the tab.
3. **Inflexibility** – nuclear would lock the UK into a centralised distribution system for the next 50 years, at exactly the time when opportunities for microgeneration and local distribution network are stronger than ever.
4. **Undermining energy efficiency** – a new nuclear programme would give out the wrong signal to consumers and businesses, implying that a major technological fix is all that's required, weakening the urgent action needed on energy efficiency.
5. **International security** – if the UK brings forward a new nuclear power programme, we cannot deny other countries the same technology*. With lower safety standards, they run higher risks of accidents, radiation exposure, proliferation and terrorist attacks

Energy efficiency in both domestic and commercial sectors is increasing at an unprecedented scale in most western countries. Even for tackling climate change, adopting nuclear in place of alternatives, due its long gestation period not only reduces but retards carbon displacement. Energy management from both demand side and alternative supply side are more cost-effective than nuclear.

Box 5 Some available and future sources of information for costing measures to meet CO_2 targets

TfL CO_2 emissions from the transport sector and broader economy
A very useful exercise containing historic and projected CO_2 emissions by

[21] http://www.sd-commission.org.uk/pages/060306.html

transport mode, technology and fuel. CO_2 emissions reduction potential from behavioural and infrastructure changes have been calculated. Contact – Mark Evers, TfL

Investment requirements and opportunities for long-term sustainable energy in London (London Energy Partnership work)
A study looking into the investment opportunities for a range of scenarios to meet the carbon reduction targets that have been set for London and an assessment of the sources of investment available along with options for delivery mechanisms. Identification of key partners and organisations required to implement the recommendations of the study. Contact – Paula Kirk, GLA.

Greenpeace and Mayor of London – Powering London into the 21st century
This work looks at a decentralised energy solution for London. Main ways of undertaking this includes – energy efficiency measures in buildings, large/medium/small scale CHP, domestic CHP, energy from waste and biogas CHP and other measures, such as photovoltaics and building integrated wind energy systems. Scenarios take into consideration number of domestic and non-domestic buildings using these technologies. Contact – Lucy Padfield, GLA

London community heating study
The study contains economic and environmental analysis of community heating (CH) across London and the technologies that could be used to supply low carbon heat. The study contains a net present value and cost comparison of nine CH schemes identified in four priority areas. Contact – Lucy Padfield, GLA

Energy efficiency uptake – GLEAM
Able to Pay scheme development:
This will look at the feasibility of using incentive schemes for householders amongst householders able to pay for a proportion of energy efficiency improvements to their homes. The work goes on to look at the prospects for rationalisation of schemes and the development of best practice. Findings have been used to inform a business plan for a Londonwide prototype scheme to encourage more activity by Able to Pay householders. Contact – Harry Mayers

4. Economics of adaptation measures

Some impacts of climate change are inevitable requiring adaptation measures such as increased flood defences. In the UK, around £800 million per year is spent on flood and coastal defences and even with these the UK experiences an average of £1.4 billion worth of damages per year[22]. Engineering and construction costs are expected to increase with increase in flood risks. It is estimated that in 20 years, the annual flood engineering and construction cost would be between £700 million and £1.1 billion, compared to £500 million today[23]. London is potentially exposed to a far greater risk from flooding than any other urban area in the UK. This is due to the value of its assets and the fact that it lies within the flood plain of the River Thames. The government has designated the Thames Gateway as one of the main growth areas to address housing shortages in the south east. The total asset value of new residential and commercial properties within the Thames Gateway is estimated to be around £19

[22] http://www.foresight.gov.uk/Previous_Projects/Flood_and_Coastal_Defence/Reports_and_Publications/Executive_Summary.pdf
[23] Ibid

billion. This represents a 15 per cent increase in flood exposure in London over the £126 billion worth of assets currently at risk in the Thames floodplain[24]. The financial costs of flooding across the new development area in the Thames Gateway is estimated to be around £17.7 million for residential properties and £29.4 million for commercial properties[25].

Increased risk of flooding due to change in the climate could lead to damage to buildings and disruption of London's transport network. In the longer term this may require substantial investments to improve ways of managing flooding such as the Thames Barrier. The Thames Barrier completed twenty years ago, normally used 11 times a year, was closed 24 times in 2001 and 19 times in January 2003 alone[26]. The key policy question for London's economy is who pays for these defences, as the cost of not adapting could be very high. It is estimated that if just one flood broke through the Thames Barrier it would cost around £30bn in damage to London[27].

5. London's role (and role of cities) in sustaining international collective action.

When it comes to practical action on the ground cities are centre stage and large cities especially can provide leadership and have a substantial impact on delivering climate change programmes. Cities are vulnerable to the impacts of climate change, for instance through the heat island effect or through their locations, often on rivers or near coasts. At the same time cities have an opportunity to go further in reducing greenhouse gas emissions, for instance through their capacity to benefit from combined heat, power and cooling or low carbon transport systems.

For this reason the GLA brought together in October 2005, twenty of the largest cities from across the world, in collaboration with ICLEI (International Council for Local Environmental Initiatives)[28], to consider best practice and agree to form a coalition ('C20') of large cities commited to leadership on climate change that could drive down their own emissions, act as champions and stimulate business and national government action on climate change.

Cities agreed on the following actions:

- Commit to work together to set ambitious collective, individual, but differentiated targets for reducing greenhouse gas emissions.
- Commit to ensure that we have higly effective agencies or programmes dedicated to accelerating investments in municipal and community greenhouse gas emissions reductions and adaptation.
- Commit to develop, exchange and implement best practices and strategies on emissions reductions and climate adaptation
- Commit to develop and share communications strategies that sensitise citizens and stakeholders to climate change issues.
- Commit to create municipal procurement alliances and procurement policies that accelerate the uptake of climate friendly technologies.

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24 http://www.abi.org.uk/display/File/Child/554/Making_Communities_Sustainable_housingsummary.pdf
25 Ibid
26 http://www.environment-agency.gov.uk/yourenv/639312/641105/644165/?lang=_e
27 http://www.wwf.org.uk/news/n_0000001510.asp
28 http://www.iclei.org

The Summit was supported by BP, EDF Energy and Thames Water and featured a range of world experts from world cities, including Sir David King, the UK Government's Chief Scientific Advisor, and Dr Jaime Lerner from Curitiba in Brazil.

The C20 is aiming to develop some 'big hit' projects and to consider how they could take advantage of economies of scale, through creating sustainable procurement alliances, in order to bring down the price of low carbon technologies so that they become commercially viable.

More recently the Mayors of Berlin, London, Paris and Moscow met together in February 2006 and agreed to work together and with the 'C20' group of large world cities to take the action forward.

ICLEI's Eco-Procurement Program, launched in 1996, is a leader in promoting green purchasing among governments, businesses, and other institutions across Europe. More than 50 cities and other local governments in 20 countries now belong to the group's Buy-It-Green Network, which helps members exchange information and experiences, join forces, and make joint green purchases[29]. The organization also holds yearly conferences and publishes a magazine that is distributed to more than 5,000 purchasers in Europe. And in one of the first efforts of its kind, ICLEI is working on a project to quantify the environmental savings associated with green purchasing, in order to determine how best to strategically join the purchasing power of cities and to spread green purchasing across Europe[30]. For instance, the project has found that replacing the 2.8 million desktop computers that EU governments buy annually with energy efficient models could reduce European emissions by more than 830,000 tons of carbon dioxide equivalent.3

Governments, corporations, universities and other institutions can play a significant role to reduce their environmental impact. Green purchasing can send the right signals to the market both for encouraging new technologies and for polluting technologies to tidy up their act. There is immense scope for the public sector to initiate the adoption of new sustainability technologies (green electricity, energy efficient lighting, remanufactured resources etc). This would stimulate new markets, manufacturing and retain opportunities, and provide the required jobs and skills.

5.1 London's environmental effectiveness

Londoners are already environmentally effective on a number of indicators. The high concentrations of people and economic activity in London enable higher environmental efficiency, whether in resource use per head of population or per unit of output (GVA). For example, higher usage of public transport in London leads to lower per capita and per output emissions from transport than in other English regions.

[29] International Council for Local Environmental Initiatives, "BIG-Net: Buy-It-Green Network," www.iclei.org/europe/ecoprocura/network/index.htm

30 International Council for Local Environmental Initiatives, "RELIEF-European Research Project on Green Purchasing," at www.iclei.org/europe/ecoprocura/relief/index.htm

Table 2.3 Total road transport CO_2 emissions per GVA and per capita (2003)

Region	Total road transport and London Underground CO_2 emissions	Tonnes CO_2 / £1 million GVA	Tonnes CO_2 / capita
East	12,374,481	129.8	2.3
East Midlands	9,296,072	150.7	2.2
London	**7,839,216**	**50.6**	**1.1**
North East	4,457,187	137.8	1.8
North West	10,844,679	111.1	1.6
South East	19,126,932	128.6	2.4
South West	10,507,650	139.8	2.1
West Midland	11,013,175	142.4	2.1
Yorkshire & Humber	9,455,128	132.7	1.9

Source: GLA Economics and Office for National Statistics

The GLA Economics report *Environmental Effectiveness of London* looked at a range of indicators comparing the relative environmental performance of London with the rest of England. The key findings, in addition to those shown in the table above, are:

- In 2002, household electricity consumption in London was 0.09 GWh (Gigawatt hour) per £1 million of Gross Value Added (GVA). The average in all other regions was 0.13 GWh per £1 million of GVA[31].
- In 2002-03, household waste production in London was 0.46 tonnes per capita, while the average for all other regions was 0.53 tonnes per capita.
- For the period 2000-01 to 2002-03, London had the second highest level of total water consumption. However, water consumption per £1 of output was lowest in London at 2.9 litres per pound (£) of GVA in 2002-03, while the regional average (excluding London) was 3.6 litres per pound (£).
- In 2002, commercial and industrial CO_2 emissions in London were 53 kilotonnes per £1 billion of GVA. The average in all other regions excluding London was 193 kilotonnes.
- Commercial and industrial gas sales in London were 238 GWh per £1 billion of GVA in 2002. In all other regions excluding London the average was 557 GWh.

London's environmental effectiveness means that investing in infrastructure and other supporting services in London to underpin its continued economic vibrancy should generate environmental benefits. If such investments are not made, and some part of London's population and economic activity relocates to other parts of the UK with more dispersed patterns of development, the environmental impact would be detrimental.

6. Main bottlenecks and barriers

[31] In this report, the average of all other regions is a simple average and does not take into consideration the relative size of GVA or population in each region.

London has a significantly higher proportion of flats and solid-walled properties than the national average, meaning that there fewer opportunities to use two of the most cost effective energy efficiency measures - loft and cavity wall insulation – in the region. This, along with the increased local cost of labour, materials, and transport means that the Greater London region receives significantly less than its per-capita share of Energy Efficiency Commitment (EEC) funding, because EEC has been designed to achieve specific energy savings at the lowest cost.

6.1 Why isn't London getting it's fair share of investment for sustainable energy?

There are a range of barriers to investments in Community Combined Heat and Power (CCHP), renewables and energy savings measures. The following is an analysis of some of the barriers, and there are doubtless more.

- The implementation issues are different in **new build vs. retrofitting**. In **new build**, the planning mechanism can be used to ensure consideration of CCHP and renewables, and new Part L Building Regulations should ensure better energy efficiency. It is also the case that the effective **costs** of micro-renewables such as PV and BIWT are lower in new build as they can be built into the building fabric. The issue here is **enforcement**, both of building regulations, and of energy policy in planning.
- For **existing buildings**, which make up the vast majority of stock, there are more serious barriers to investment. For standard CHP projects, a low **spark spread** means that incentives are not good. For more complex schemes (e.g. including thermal storage, summertime cooling and private wire) there can be substantial **coordination problems**, as these projects work best with a mix of different energy loads. There are also currently **regulatory barriers** to supplying more than about 1,000 domestic customers directly.
- For retro-fitting micro-renewables, the lack of a guaranteed payback for power exported to the grid is often seen as a major obstacle
- A large proportion of London's homes have no cavity walls and/or no loft. Loft and cavity wall insulation have relatively high energy savings rates for the initial outlay. Hence they are an attractive option for energy suppliers, as the cost of achieving their allotted target of the Energy Efficiency Commitment must come from their bottom line.
- The housing stock in London means that many homes cannot be helped by the majority of Energy Suppliers schemes and that only limited measures can be provided through Warm Front to these properties if the occupiers are eligible to the scheme.
- For fuel poverty a major barrier remains the ability to target households in fuel poverty.
- For **commercial energy efficiency**, the main barrier is that even with rising energy prices, **energy costs are small** relative to rents (especially in central London), and most tenancies create a split incentives whereby neither landlord nor tenant have an incentive to invest in energy efficiency.
- For major refurbishments, the EPBD should help energy efficiency somewhat, through the operation of the new Building Regulations (subject to enforcement). However, decisions on the strongest driver **– labelling and display –** have been delayed.

6.2 Storage, congestion, parking and the congestion charge

The following have been cited as reasons for installers not marketing hard in London or not being interested in installing in London:

- Lack of storage in London which is needed by solar water heating installers: Need a place to store solar water heating panels and parts otherwise it is very difficult to ensure all the relevant parts are at the installation site on the correct day, travel cost, parking cost, congestion charge.
- Congestion: The time required to get to a building can cause installers to avoid coming to London. Alternatively they may not do that particular job until they have another in a similar area. This can lead to delays in installation and affect the confidence of those who refer householders to the schemes.
- Parking: the cost and difficulty of obtaining parking permits presents a problem. For cavity wall insulation in particular, the vehicle must be parked within a certain distance from the house.
- Congestion charge: this has been cited as an additional cost that makes it more profitable to work in other areas.

6.3 Other unconfirmed possible issues for London

The following are other possible factors that have been suggested for London not achieving it's fair share of sustainable energy investment. However, none of these have been confirmed and should be read in this light:

- Higher cost of labour: as energy suppliers are not confined to a particular area, it may be cheaper for them to attain their savings where the cost of labour is lower.
- High turnover: In some areas of London the turnover of tenants is very high. This could mean that people aren't in accommodation long enough for the improvements to occur where the waiting time is high for a particular scheme or it isn't worth the disruption for the short time that they are in the property.
- Tenure: London has a high proportion of privately rented homes 16% compared to 10% for England. If housing energy efficiency is analysed by occupier type or tenures, the highest proportion of homes without insulation is private rented properties. Around 234,000 households have no central heating (75,000 of those are in private rented. This reflects the different incentives that landlords and tenants have especially if tenants are responsible for energy costs.
- The Energy Efficiency Commitment 2 DEFRA model assumes approximately 85% of homes improved will be gas heated i.e. reflecting the opportunity. This may be another factor for London? As it has a lower than national average gas heated homes.
- The key reasons why owners and tenants of commercial buildings don't invest more in energy saving measures are:
  - information search costs
  - energy costs (even with current high prices) are tiny compared with rents (especially in Central London)
  - there is no proven rental premium for a "green" office outside a niche market

7. Some Additional views issues mentioned in the Stern discussion paper

7.1 Action to reduce CO_2 emissions could affect growth rate and competitiveness

Climate change is a global problem and any cost effective measure or policy would require a level playing field to avoid adverse impact on competitiveness. If not any CO_2 reduction by one country could be offset by an increase in other. The situation in China and India is a clear example. In addition to steps taken by developed countries to reduce their emissions, it is equally important to provide access to clean technology in developing countries.

7.2 Key questions from the Stern Review

What is the potential for adaptation to changes in the climate, and how might this vary by country and region?

The potential for adaptation to changes in climate will depend on:

- vulnerability to extreme weather
- regional planning
- construction codes
- protection measures
- emergency organisation

How can action be taken to make deep cuts in greenhouse gas emissions without a significant reduction in the rate of growth and competitiveness? Can innovation and technological change help us to move to higher growth paths?

The London Climate Change Agency is a central part of London's answer here. A key part of the rationale for the Agency is market failure in innovation.

How can policymakers create sufficiently clear and credible signals and the institutions to support them?

Better regional planning mechanisms looking at the cost effectiveness of both mitigation and adaptation measures.

What are the market barriers and failures that may prevent the development and deployment of new and existing low carbon technologies, and what are the appropriate policy instruments to overcome these?

In addition to those mentioned in the document:

The financial sector has a very important role to play in tackling climate change. This sector has the potential to provide monetary incentives to direct finances towards sustainable green economic activity; encourage 'green investment funds'; and help investors, lenders and insurers account for climate risk in their decision-making criteria. There is a lot of uncertainty about environmental regulations and commitment of regulators for consistent emission reduction targets. Government also need to be aware of the compliance costs of adhering to changing regulations. Currently, there is preponderance of duplicative policies trying to address one issue (climate change levy, UK and EU ETS, renewable obligation certificates, climate change agreements). This imposes a transaction cost on small businesses and does not send the right signal.

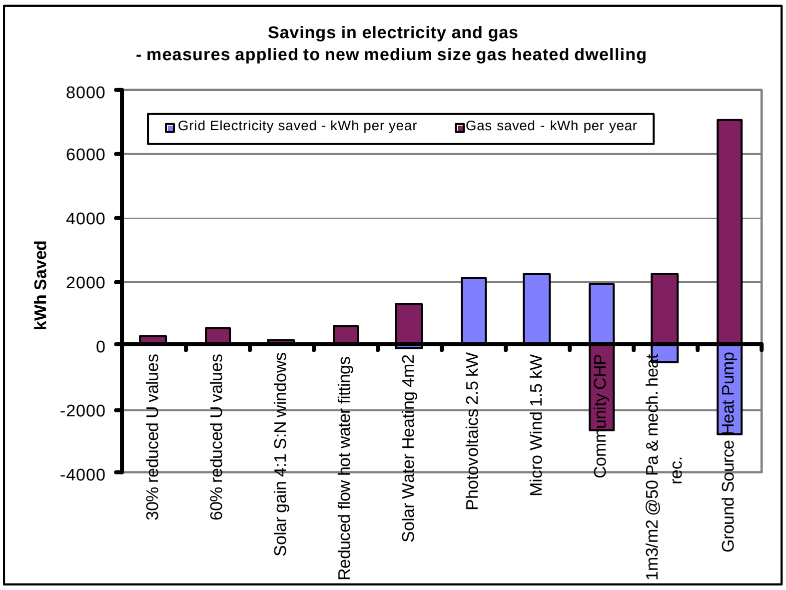
Policy makers need a better understanding of the role and functions of the financial services industry's segments. Each segment plays a unique role in helping understand the risks of climate change and determining how these risks should be included in investment decisions.

Governments also need to be more innovative in creating attractive opportunities within the clean technology and energy efficiency sector.

Work more closely with developing countries to initiate and develop good quality GHG projects under the Kyoto protocol

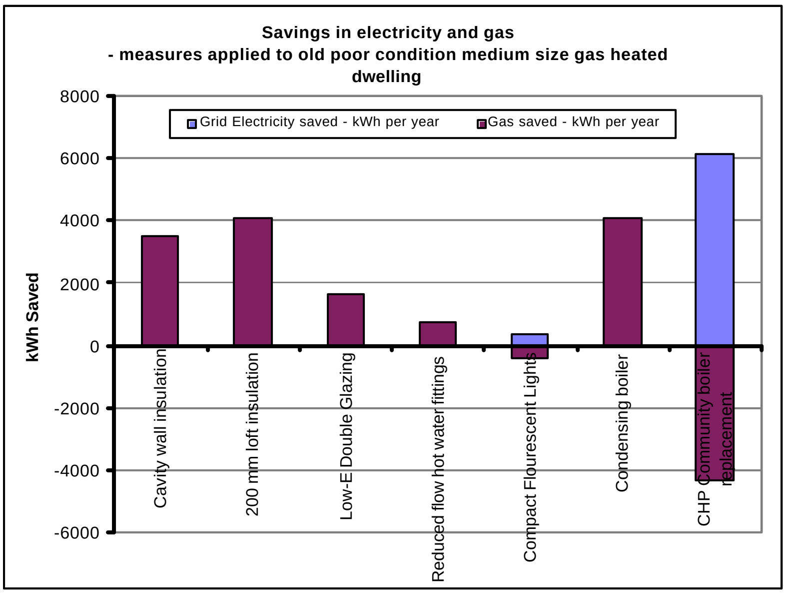
Annex

Larger fuel savings are possible by using low-carbon measures on older dwellings.



New homes:

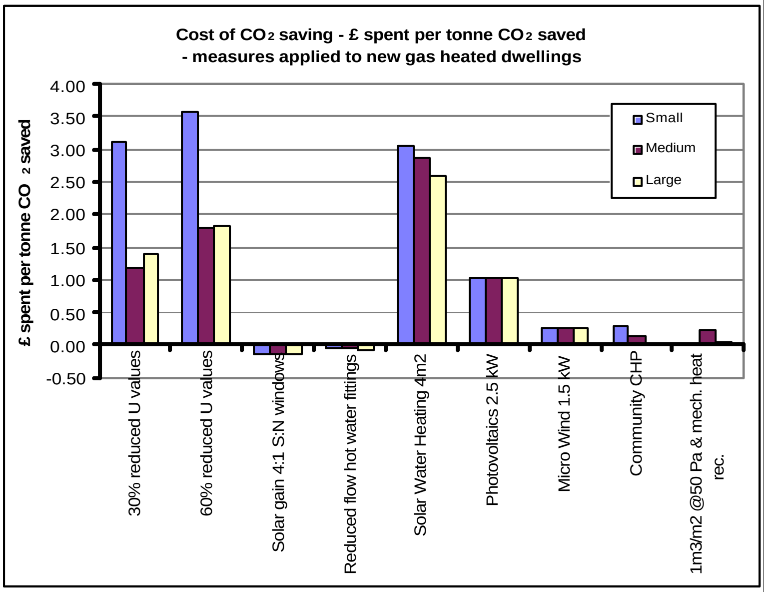
- Conversion to electric heating using GSHP provides the largest reduction in energy use.
- CHP requires a net increase in fuel consumption.
- Mechanical heat recovery and solar water heating both provide significant gas savings but require electricity for pumps and fans.
- U-value reduction only provides a negligible reduction in heating demand due to the current stringent regulations already in place.



Existing homes:

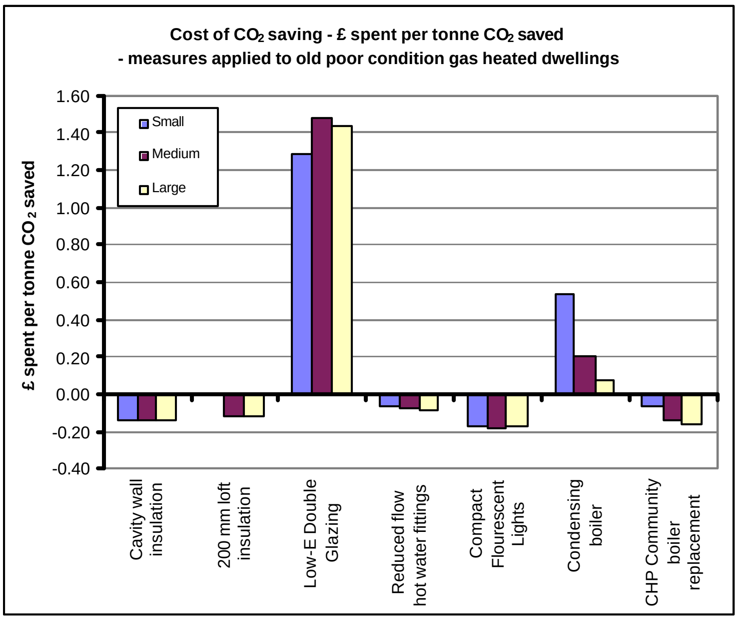
- Cavity wall insulation, loft insulation and condensing boilers provide the largest reduction in heating fuel.
- CHP community boiler replacements displace significant amounts of grid electricity and also improve on the existing heating efficiency providing a net energy saving.
- CFLs reduce electricity consumption but cause an increase in heating demand.
- Low-flow hot water fittings enable a saving of 750 kWh per year through reduced hot water consumption.

Cost neutral carbon savings are more easily achievable in older dwellings



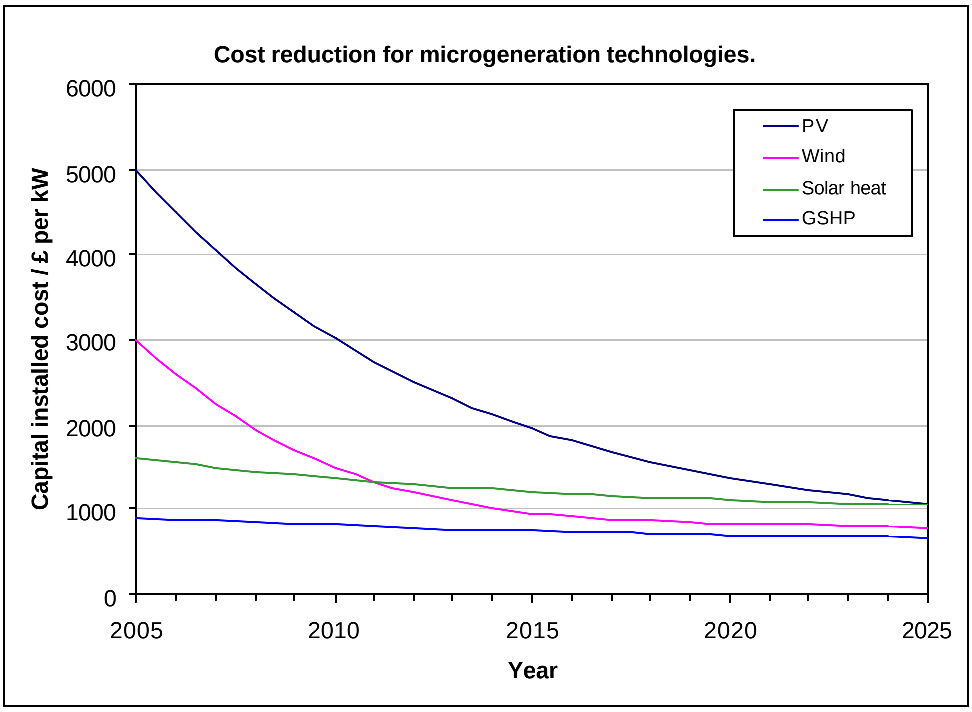
New:

- Only solar gain (which is theoretically free) and reduced flow hot water fittings provide CO_2 savings free of charge.
- Due to the already low regulated U-values, further improvements require significantly thicker insulation which is uneconomic to install.
- Solar water heating has the highest costs across all sizes due to the high capital cost, and the displacement of relatively low CO_2 intensity natural gas. In an electrically heated dwelling, CO_2 savings would be higher and the cost greatly reduced (although still higher than PV and micro wind due to the lower energy saving).



Existing:

- All measures apart from double glazing and condensing boilers give a negative cost per unit CO_2 saved.
- Low energy lighting (CFLs) are the most cost-effective measure followed by cavity wall insulation and CHP community boiler replacement.
- Double glazing is an uneconomic method of reducing CO_2 due to the high capital costs.


Cost reduction for microgeneration technologies.
PV
Wind
Solar heat
GSHP
Capital installed cost / £ per kW
6000
5000
4000
3000
2000
1000
0
2005
2010
2015
2020
2025
Year