A note on the importance of fast acting mitigation measures

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Of critical importance is global warming over periods of decades, the time integrated radiative forcing of greenhouse gases, and so early, small reductions in GHGs can be as important as later larger reductions, especially given the increasing concern about ‘tipping points’. Measures such as motorway speed reduction (< 5 years implementation) and car downsizing (~15 years) can be implemented faster than building refurbishment (~30-40 years), though the ultimate energy and carbon reductions of the faster measures may not be as great as the slower measures. This analysis is preliminary but the estimates of effects may be accurate enough to demonstrate the importance of fast acting measures, especially given future uncertainties, and thus be worthy of further investigation.

The next Table gives some illustrative measures.

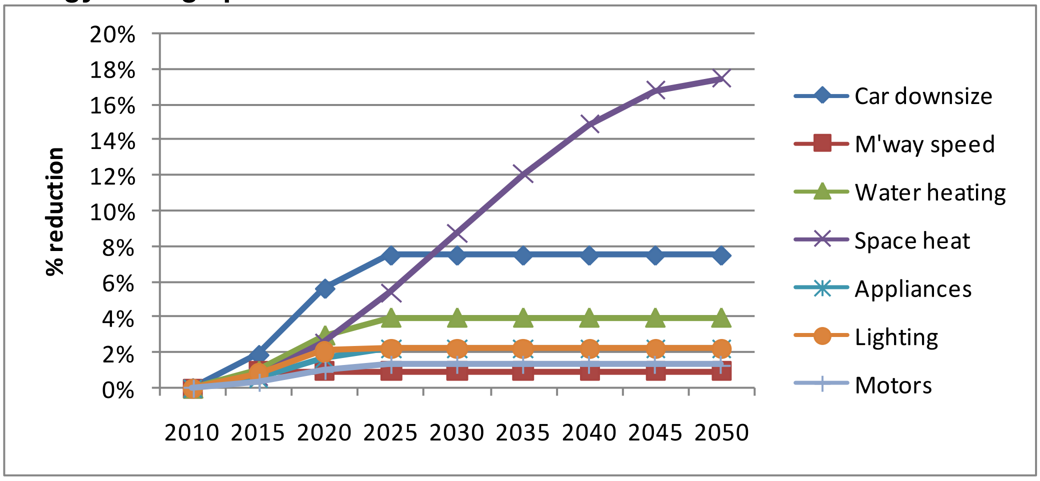
Table 1 : Illustrative demand management measures

	UK Carbon %	Measure	Measures Reduction %	UK Reduction %	Yrs
Transport	15%	Car downsize	50%	8%	15
	24%	M'way speed	4%	1%	5
Heat	8%	Water heating	50%	4%	15
	25%	Space heat	70%	18%	40
Electricity	5%	Appliances	50%	2%	15
	5%	Lighting	50%	2%	12
	3%	Motors	50%	1%	15

In this illustrative analysis, no account is made of synergies which will reduce the effect of individual measures – for example, reducing the speed of a small car will cause less carbon reduction (in tonnes) than of a large car.

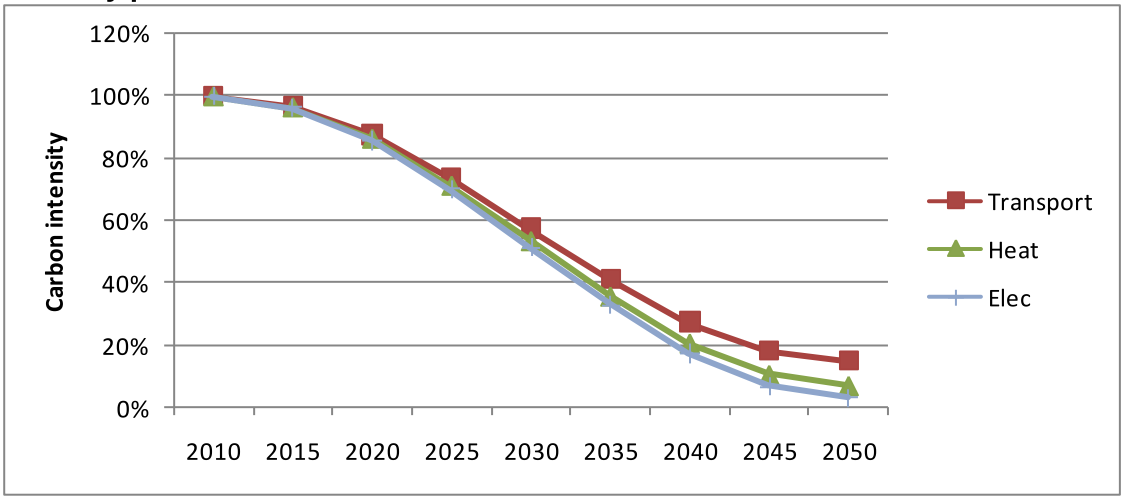
The next Figure illustrates the energy savings of demand reduction measures in any year given their maximum potential and rates of implementation.

Figure Fejl! Ingen tekst med den anførte typografi i dokumentet.**-1: Demand management energy savings profiles**



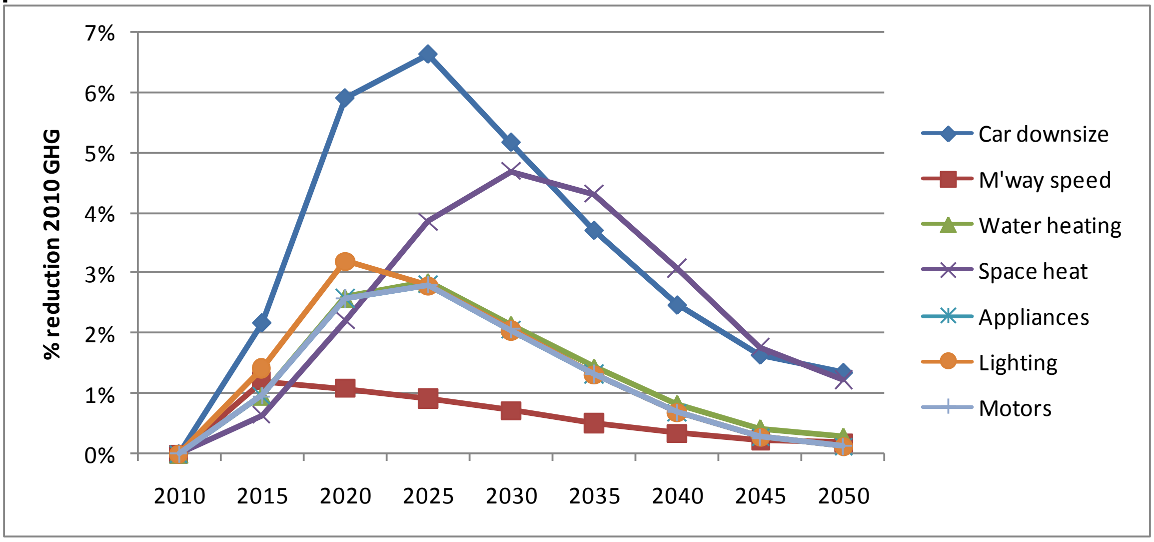
The next Figure illustrates how the average carbon intensity of transport, heat and electricity supply might be reduced as renewable energy is introduced. (In fact, marginal analysis should be used here, especially for electricity, as the first savings will tend to displace the most carbon intensive marginal plant such as coal.)

Figure Fejl! Ingen tekst med den anførte typografi i dokumentet.**-2: Energy supply carbon intensity profile**



Then the carbon emission reduction in any year of a measure is found by multiplying its energy reduction by the carbon intensity, as shown in the next Figure.

Figure Fejl! Ingen tekst med den anførte typografi i dokumentet.**-3: Carbon reduction profile**



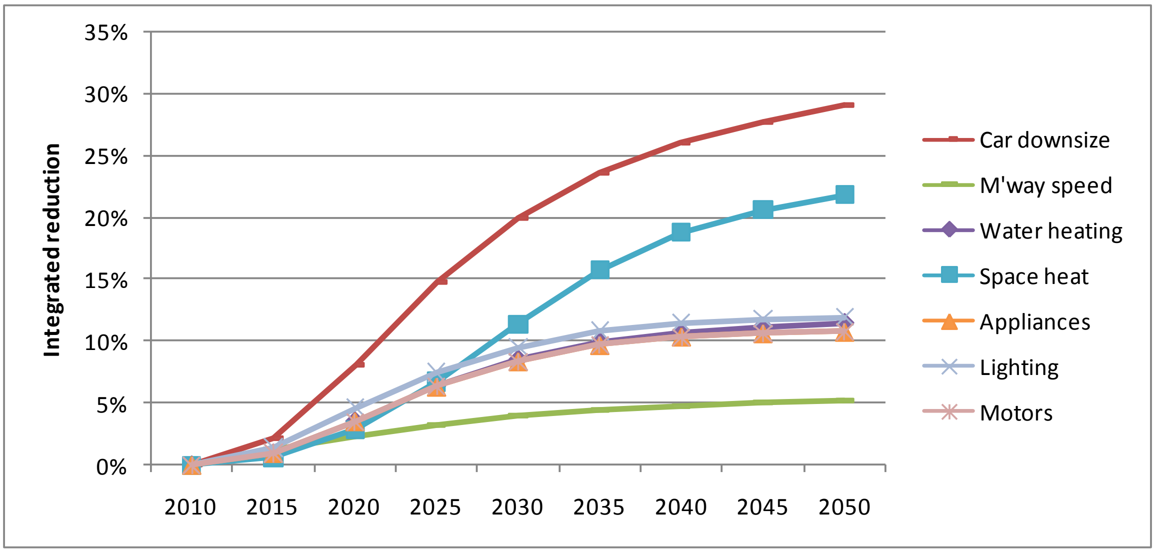
This shows how this will increase, relatively, the carbon savings per unit of energy of the faster measures as they will have more effect whilst supply is still carbon intensive. For example, reductions in electricity demand through fast acting lighting or appliance efficiency will mainly reduce generation from coal and other marginally carbon intensive generation in the short term, whereas, ultimately, energy efficiency will effect no carbon reduction in zero carbon supply systems of the more distant future, although it should still be implemented for short and medium term energy and carbon reductions, and because efficiency is cost-effective against renewable supply.

A further benefit of the faster measures is that it makes it easier to meet near term objectives such as percentage renewable energy targets for 2020 or 2030 – a one percent demand reduction reduces renewable supply requirement by one percent.

<u>In this way, the demand management will in turn increase the rate of decarbonisation of supply. This marginal system effect is not explored here, and yet it would further increase the importance of fast measures</u>.

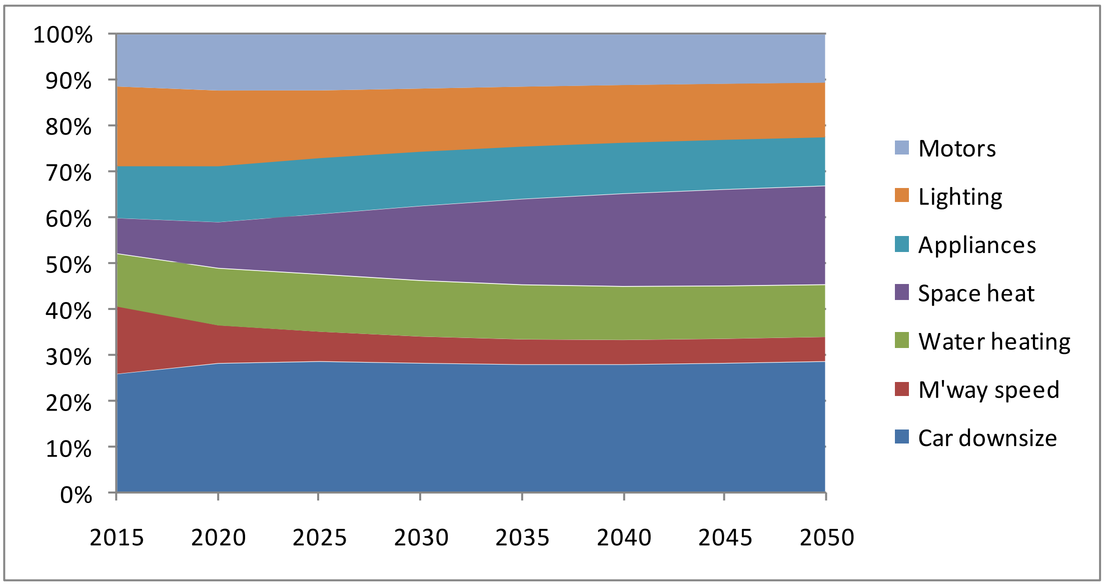
The next Figure shows the carbon reductions of the previous Figure accumulated from the year of introduction.

Figure Fejl! Ingen tekst med den anførte typografi i dokumentet.**-4: Demand management carbon reductions cumulated from 2010**



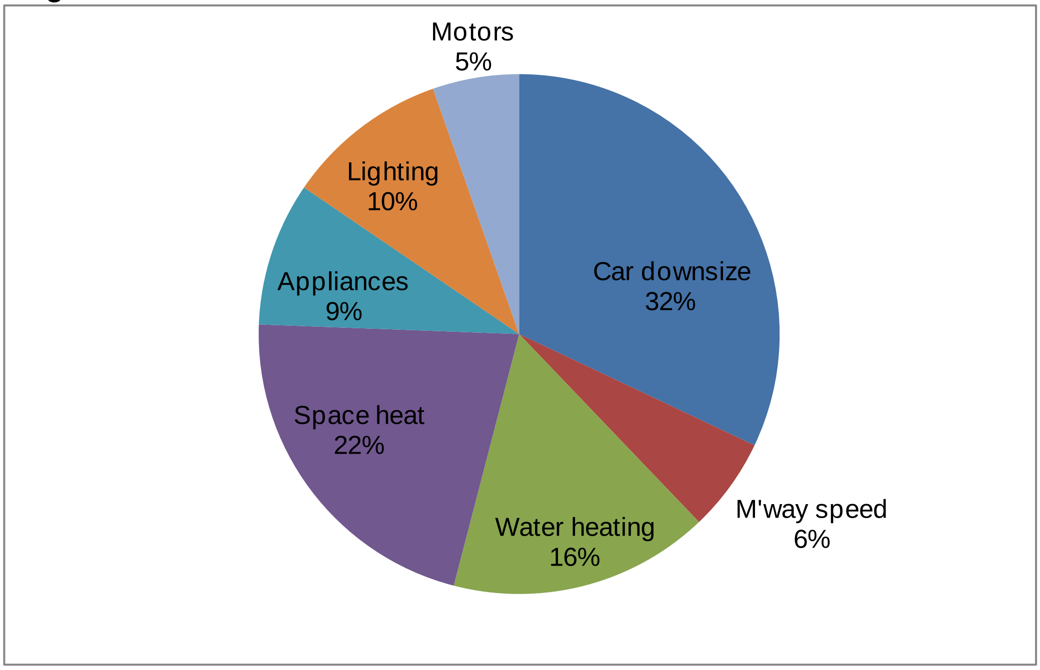
The next Figure shows the cumulative carbon reductions shown as a fraction of total reduction.

Figure Fejl! Ingen tekst med den anførte typografi i dokumentet.**-5: Demand management carbon reductions cumulated from 2010**



The next Figure shows a snapshot of the total carbon reduction over the period 2010-2030.

Figure Fejl! Ingen tekst med den anførte typografi i dokumentet.**-6: Demand management integrated CO_2 reduction 2010-2030**



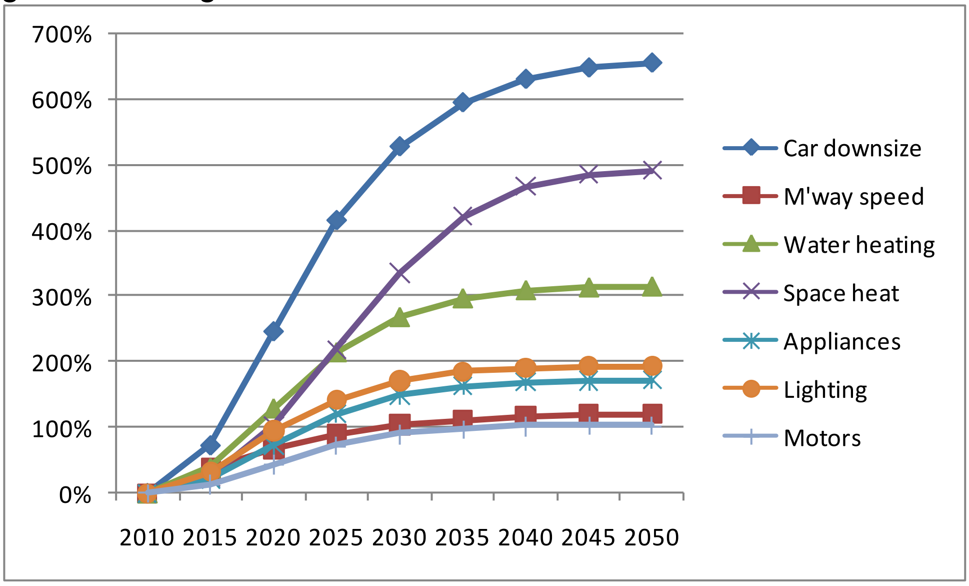
The preceding has given estimates of carbon reductions year by year and cumulated over a period of years.

The next step is to calculate the total reduction in global warming over a period, in this case 2010 to 2050. This is done by multiplying the reduction in atmospheric carbon by an index of global warming. This index should include:

- An index of the radiative forcing of the emitted greenhouse gas for each year which should account for the residence times of GHG; CO_2 which has a long residence time (e.g. compared to methane) such that in this analysis a negligible fraction of the CO_2 is assumed to be removed from the atmosphere before 2050 – i.e. the residence index (***Ir***) is taken as 1.
- An index, ***If***, to account for positive feedback functions such as snow melt which will accelerate GW – the tipping point phenomenon – and which will increase the importance of early reductions; this index, ***If***, is taken as 1.

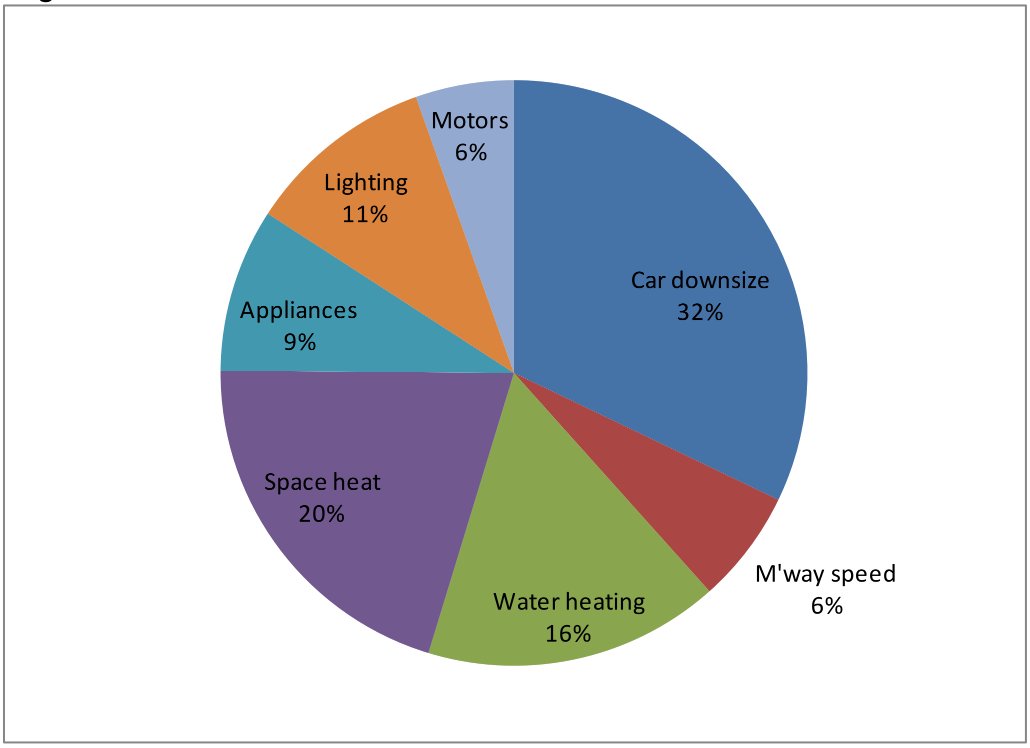
In this simple analysis the combined index (***Ic***) is taken as 1 (= ***Ir*** x ***If***) which probably leads to an underestimate of the importance of early reductions. We then multiply the carbon reduction in any year by the combined index, and cumulate across the years to estimate total GW reduction of the measures, this is shown in the next Figure.

Figure Fejl! Ingen tekst med den anførte typografi i dokumentet.**-7: Demand management global warming reductions cumulated from 2010**



The next Figure shows a snapshot of the total GW reduction over the period 2010-2030.

Figure Fejl! Ingen tekst med den anførte typografi i dokumentet.**-8: Demand management integrated GW reduction 2010-2030**



The implication of this analysis for global warming mitigation are plain: early reductions are important. Two behavioural demand measures, downsizing and speed, might account for more than 30% of total carbon emission and global warming reduction during the critical transition period to very low carbon emissions. This simple illustrative analysis may well underestimate the importance of fast measures on carbon reductions (because system marginal analysis was not done) and on climate change (because tipping points etc. not accounted for.)

The analysis has implications for the economic analysis of measures. Marginal Abatement Costs (MAC) are often calculated as (Total Annuitised Cost / Total Emissions Abated). But if the indicator were to be Global Warming (2010-2050) and Mitigation Costs (GWMC_2010-2050) then the ordering of measures by cost-effectiveness could change substantially, and thence, possibly, policy implications. (Note that all such marginal cost curves, including MACs and GWMCs, can be misleading because measures are often synergistic and so cannot be independently costed and summed.)

This analytic approach may have application to impacts on other environmental systems that have analogous properties; where the total integrated impact is important, and where there are positive feedbacks, or non-linear responses, or thresholds. For example, acid emission, deposition and impact.