The greenhouse gas implications of future water resources options

Reducing emissions of greenhouse gases is one of the key challenges facing our generation.

This paper outlines:

- the scale of greenhouse gas emissions related to water company activities and household use of water;
- the implications which new water supplies and demand management measures could have on future emissions.

Consideration of the greenhouse gas implications for water resources is a new area of work for regulators and water companies. Water companies are now required for the first time to include the cost of greenhouse gas emissions in their evaluation of water resource options and to give details of annual emissions associated with their water supply activities.

We are committed to achieving a high quality environment, now and in the future. We recognise that lower greenhouse gas emissions are fundamental to delivering environmental improvements in a sustainable manner. Our science report[i], which complements this summary paper, provides the detailed evidence and presents a methodology for assessing the carbon costs and benefits of future water resource options.

Throughout this note we also use carbon as shorthand for greenhouse gases.

The key findings of our new study are:

- When household and water company emissions are considered together, we calculate that 89 per cent 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. The remaining 11 per cent of emissions originate from abstracting, treating and supplying water, and subsequent wastewater treatment.
- Simple demand management measures – particularly those which reduce hot water use – have significant potential to not only save water and energy, but also to reduce the carbon footprint throughout the water system. Small actions by individuals could together result in a significant reduction in greenhouse gas emissions, with the added benefit of lower energy and water bills.

- All new supply side infrastructure measures result in an increase in greenhouse gas emissions. Desalination has the greatest potential to increase emissions, followed by effluent re-use and reservoir options. There is however a very wide range of emissions associated with similar supply options, so to select the lowest carbon solution requires a scheme by scheme assessment.

This work supports the development of our water resources strategy, providing the initial evidence base for our policies and an improved understanding of the greenhouse gas emissions associated with different water supply and demand management options.

The scale of emissions

The UK Government is committed to a significant reduction in greenhouse gas emissions. The Stern Report, Energy White Paper and Climate Change Bill provide the scientific and legislative impetus to all sectors to take action to lessen the impact of emissions and to adapt to their effects.

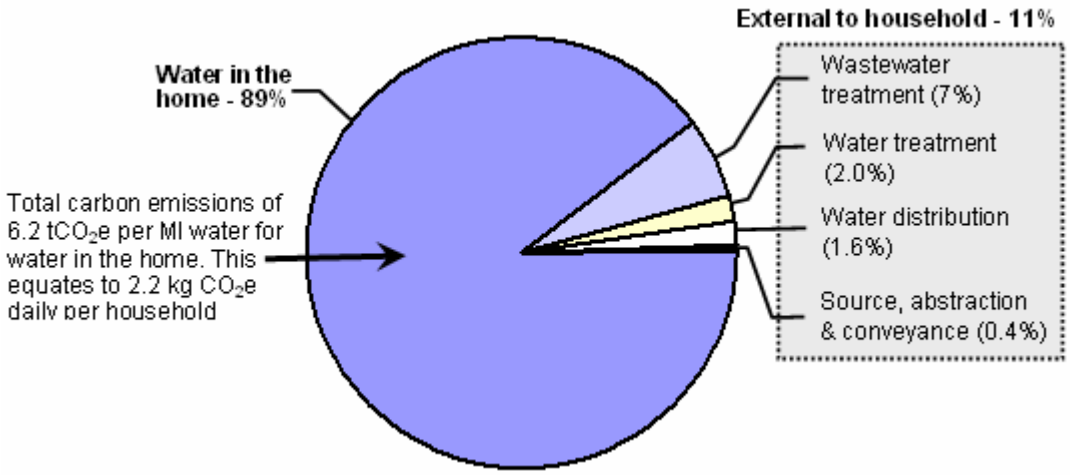
In 2006/07 the UK water industry emitted five million tonnes of greenhouse gases through treating and supplying clean water, and dealing with wastewater and sewerage. This statistic means that the 23 companies making up the water industry were responsible for 0.8 per cent of annual UK greenhouse gas emissions. Emissions have risen significantly from the four million tonnes reported in 2005/06, though this may reflect improvements in reporting by water companies as well as a real increase in emissions.

Around 56 per cent of emissions from water companies derive from wastewater, 39 per cent from water supply and five per cent from administration and transport. The use of hot water in homes for activities such as personal use and household washing, cooking and cleaning, but excluding water used in heating the home, contributes roughly 35 million tonnes of greenhouse gases each year. This is seven times as much as that emitted by the water industry and amounts to 5.5 per cent of total UK emissions.

When household and water company emissions are considered together, we calculate that about 89 per cent of carbon emissions in the water system can be attributed to ‘water in the home’ (Figure 1). This includes energy for heating water but excludes space/central heating. The remaining 11 per cent of emissions originate from abstracting, treating and supplying water, and subsequent wastewater treatment.

Looking across the life-cycle of water supply, household water use and sewage treatment, we calculated that for every million litres of water almost 7 tonnes of carbon dioxide is emitted. Of this total carbon emissions from ‘water in the home’ are 6.2 tonnes of carbon dioxide equivalent (CO_2e) per million litres (Ml) of water. This equates to each household emitting 2.2 kg of CO_2e every day. Over a year this is the same level of emissions as is produced by driving 2,400 miles in an average family car.

Figure 1: Breakdown of carbon emissions from the water system in the UK



Findings

Water resource planning follows a "twin track" approach to meeting new demand – using water more efficiently and providing additional supplies. Our science report findings have implications for both approaches, summarised below:

Demand management measures
Simple demand management measures – particularly those which reduce hot water use – have significant potential to not only save water and energy, but also to reduce the carbon footprint of the water system (Annex 1).

For example, moving to full metering in areas of serious water stress could potentially reduce annual emissions by between 0.5 – 0.75 million tonnes CO_2e per year. Moving to full water metering across England and Wales could potentially reduce annual emissions by 1.1 – 1.6 million tonnes CO_2e per year from current levels.

To place this in context, the Government's Carbon Reduction Commitment (CRC), an emissions trading scheme covering large organisations in the public and private sectors including water companies, aims to deliver emissions reductions of four million tonnes of CO_2e per year by 2020. The CRC is a new trading scheme for business and public sector organisations which are significant energy users but do not currently participate in other emission trading schemes or climate change agreements. Achieving full household water metering could deliver a significant emission reduction, equivalent to 27-40 per cent of the CRC target.

The findings from this report are also good news for household utility bills. In the face of rising energy prices, water metering alone could reduce customers' water and energy bills by between £40 and £160 per year.

Supply side carbon emissions
All supply side infrastructure measures result in an increase in greenhouse gas emissions (we assume new schemes are implemented to meet rising demand rather than replacing existing assets). Desalination has the greatest potential to increase emissions, followed by effluent re-use and reservoir options (Annex 1).

Schemes of a similar type often have a wide range of associated emissions and overlap between different types of schemes is common. For example, medium-to-large reservoirs and indirect reuse of wastewater can have similar greenhouse gas emissions per volume of water supplied (depending on the scheme design).

Taking a wider view

The water sector needs to play its role fully in delivering the UK's carbon targets. Improvements to the environment must be delivered in a low carbon manner. Water companies need to:

- ensure their carbon impact is minimised through increased efficiency, technological innovation, use of renewable energy and implementation of alternative, low emission solutions;

- deliver carbon reduction across the business. If new activities result in unavoidable additional carbon emissions in one area, water companies need to ensure emissions are reduced elsewhere.

The findings suggest that wherever the need for new supply sources is being investigated, demand management options should be considered. Even in areas not considered to be water stressed, pursuing demand management measures should be examined in light of the carbon benefits they bring.

Current legislation continues to require the sustainable management of rivers and groundwater. In some cases this will mean that water abstraction will need to be reduced to ensure a sustainable water environment, resulting in a reduction in the water available for supply. To offset this effect, companies are investigating alternative sources of water. Our work indicates this will increase carbon emissions overall. We believe that widespread implementation of demand management measures can offset or further reduce overall emissions, as well as reducing the need for some of these new supplies in the first place.

Water resources management plans

In their water resources management plans, water companies are required to assess only the carbon footprint related to water supply and not the associated whole life-cycle carbon costs.

In our guidance[ii] we ask water companies examining water resource options for the 25-year planning period to build the Shadow Price of Carbon into their economic analysis. The Shadow Price of Carbon typically relates to the direct energy costs of water production and greenhouse gas emissions of materials and construction activities.

Our new study provides the first comprehensive evidence for lower carbon emissions through measures that reduce demand for water in the home. But the current approach used by water companies does not require them to incorporate the largest and most significant aspects of carbon accounting when assessing whether to build new resources or to manage demand. Based on this study we believe water companies now need to consider these benefits as part of their overall assessment.

In future, policies need to consider the greenhouse gas emissions across the whole of the water system, i.e. emissions arising from both the water industry and the use of water by consumers. Policy-makers also need to recognise the potential overlap with the aims of energy efficiency initiatives and ensure there is no double counting of carbon reductions.

The life-cycle emission model

The model (see Annex 2) described in our science report can be used to compare the greenhouse gas impacts of individual supply and demand options. It allows key details of construction and operation to be adjusted to:

- reflect actual schemes;
- explore the implications of different designs in terms of greenhouse gas emissions.

This model does not include any assessment of other environmental, social or economic costs and benefits. We recognise that quantifying greenhouse gas emissions is just one factor to be considered in the overall decision-making process.

Conclusion

Our work highlights the importance of considering the level of emissions when assessing options for water resource supply and demand as part of the water resources planning process.

Simple demand management measures such as water metering have the potential to reduce greenhouse gas emissions by reducing the energy use associated with heating water in the home. Small actions by individuals could together result in a significant reduction in carbon emissions, with the added benefit of lower energy and water bills for these people.

Implementing the right balance of water demand management measures and low carbon supply side solutions can begin the process of moving towards a lower carbon water industry. Getting it wrong will leave a legacy of carbon-intensive water management which will remain with us for decades to come.

Annex 1: Carbon costs

Defra guidance sets out how to value greenhouse gas emissions based on the concept of the Shadow Price of Carbon. This captures the estimated damage costs of climate change caused by each additional tonne of greenhouse gas emission expressed as carbon dioxide equivalent.

It is difficult to compare directly the carbon costs of different options as calculations must use a common basis that takes into account different water yields or savings, asset life, total carbon emissions, and an annual rising Shadow Price of Carbon.

In this study, to make a direct comparison between water supply, individual demand management options and combined demand management options the average incremental carbon cost for the water supply-use-disposal system was calculated.

A summary of results is shown below. These are average values, based on our high level assessment. The range of life-cycle emissions associated with new supply schemes, in particular, is large. To select the lowest carbon solution requires a scheme by scheme assessment. Our study has not considered the wider economic or environmental costs of implementing these options, nor the availability of water for abstraction. Refer to our science report for a discussion of results and assumptions, including the carbon costs of demand management combinations for new homes.

	Emissions	**Carbon cost**
Demand management option*	**$kgCO_2e$/day/house**	**pence/m^3**
Metering and tariffs	2.08	25
Smart metering	2.14	25
Conventional metering	2.20	26
Efficient showers	2.25	26
Spray taps	2.38	26
Water audits	2.36	27
Efficient baths	2.30	28
Low flush toilets	2.42	28
Current water 'supply-use-disposal' carbon cost	**2.43**	**28**
Community rainwater harvesting (retrofit)	2.56	34
Individual household rainwater harvesting (retrofit)	2.67	38
Community greywater reuse (retrofit)	2.59	39
Individual household greywater reuse (retrofit)	2.71	44

* figures are indicative for each option, and are not cumulative values.

	Emissions	**Carbon cost**
New supply option*	**$kgCO_2e$/day/house**	**pence/m^3**
Current water 'supply-use-disposal' carbon cost	**2.43**	**28**
Direct ground water abstraction	2.46	29
Aquifer storage and recharge	2.47	29
River intake	2.48	30
Indirect effluent reuse	2.57	31
Reservoir	2.61	31
Desalination (brackish water)	2.91	34
Desalination (saline water)	3.77	44

* figures are indicative for each option, and are not cumulative values.

Annex 2: The life-cycle emission model

The life-cycle emission model described in our science report is introduced below. The model was developed to support our strategic appraisal of the greenhouse gas emissions associated with different options for supplying water and using water more efficiently was undertaken. Both new water supply options and demand management options working with an existing water supply network were assessed. The options considered included:

- Supply:
  - storage reservoirs;
  - regional water grids via transfer pipelines;
  - desalination plant to make seawater and brackish water drinkable;
  - wastewater reuse;
  - groundwater and river abstractions.

- Demand management options:
  - water-saving devices for toilets, showers and baths;
  - water meters;
  - water-efficient domestic appliances;
  - rainwater collection systems;
  - greywater recycling (i.e. water from showers, baths and sinks used for toilet flushing);
  - reduction in leakage from water mains.

The methodology was developed in line with Defra guidance on the Shadow Price of Carbon and Environment Agency guidance on water resources planning. We use present value techniques to compare options in terms of their carbon cost as CO_2e versus water delivered or saved over a planning horizon of 60 years.

The life-cycle impact of individual options is based on the estimated greenhouse gas emissions associated with construction, manufacture, installation, maintenance and operation.

- Current carbon emissions and cost of carbon are evaluated for a unit of water.

- For water supply options, the model calculates the carbon cost of the scheme, e.g. for a new reservoir, new treatment facilities (drinking water and wastewater) or increased capacity in the distribution network.

- For demand management options, the model calculates the carbon cost to introduce and operate the measure and the carbon savings from lower water demand.

[i] Greenhouse gas emissions of water supply and demand management options, Environment Agency Science Report SC070010/SR (2008)
[ii] http://www.environment-agency.gov.uk/subjects/waterres/981441/408371/