waterwise

A Review of Water Neutrality in the UK

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1. Introduction

This paper provides an overview of water neutrality in the UK, drawing from literature and examples that have been implemented both in the UK and globally. It outlines the benefits of water neutrality as well as the barriers that may have prevented it from becoming more widespread. Finally, it discusses ways to enable and fund water neutral initiatives. This paper focuses on water neutral new domestic housing developments and less on the broader concept of water neutrality, which can also be applied to products, businesses and existing buildings.

Water neutrality was "in vogue" around 2008 - 2010[1], but little has been done to advance the agenda forward in the last decade. Waterwise produced a discussion paper on this topic in 2008[2] and in the same year the UN were recommending water neutrality in their UNESCO Report[3]. The Environment Agency also delivered a series of reports in 2008 and 2009 assessing the feasibility of water neutrality for large scale development across the Thames Gateway.[4] While there was ambition for water neutral developments, progress has been slow in delivering water neutrality in practice in the UK since those initial studies and reports.

In recent years, the concept and allied ambition to seek water neutrality has gained renewed currency, due to the emergence of carbon, biodiversity, flood risk and nutrient neutrality. A 2018 Ofwat report[5] states that in a survey of 25 water efficiency stakeholders there were "a few mentions of water neutrality as an option to drive deep water savings". The same report suggests there could be significant water savings by introducing water neutrality as a standard for new developments in a relatively short time frame. The Bricks and Water Report, issued by Policy Connect in 2018[6], states that 'the water neutrality concept needs to be further investigated'.

[1] Ofwat (2018) The Long-Term Potential for Deep Reductions in Household Water Use. https://www.ofwat.gov.uk/wp-content/uploads/2018/05/The-long-term-potential-for-deep-reductions-in-household-water-demand-report-by-Artesia-Consulting.pdf
[2] Waterwise (2008). Water neutrality discussion paper. https://www.waterwise.org.uk/wp-content/uploads/2018/02/Copy-of-Water-Neutrality-Discussion-Paper.pdf
[3] United Nations Educational, Scientific and Cultural Organization (2008) UNESCO Report https://banyanwater.com/deep-end-water-neutrality/
[4] Environment Agency (2008), Towards water neutrality in the Thames Gateway (various reports), https://www.gov.uk/government/publications/towards-water-neutrality-in-the-thames-gateway-summary-report
[5] Ofwat (2018) The Long-Term Potential for Deep Reductions in Household Water Use. https://www.ofwat.gov.uk/wp-content/uploads/2018/05/The-long-term-potential-for-deep-reductions-in-household-water-demand-report-by-Artesia-Consulting.pdf
[6] Bricks and Water (2018) West Minster Sustainable Business Forum and Policy Connect https://www.policyconnect.org.uk/sites/site_pc/files/report/1108/fieldreportdownload/brickswaterreportwsbfweb.pdf

2. Definition

Definitions of water neutrality have varied depending on the context in which they are applied. The definition that appears frequently in literature was produced by Therival et al in 2006. They defined water neutrality as: "*For every new development, total water use in the region after the development must be equal to or less than total water use in the region before the new development*"[7]. This definition is still used widely, but in 2009 The Environment Agency changed it slightly to include mention of offsetting. Their revised definition became: *"For every new development, the predicted increase in total water demand in the region due to the development should be offset by reducing demand in the existing community"*[8].

These definitions are for new developments rather than existing developments or other applications, such as a company or product and allow for some helpful ambiguity in terms of defining the scale and boundaries of a 'region' and 'development' to suit different contexts.[9] However, the focus on offsetting could be unhelpful as it takes away from the need to initially become as water efficient as possible and consider water reuse systems before looking to offset the final water demand.

For the purpose of this paper, we will also be focusing on new developments, however the same principles can be applied to existing buildings as well. This paper does not define the region in which neutrality is applied, this will be individual to each development, local geography or project. However, offsetting for a particular project must link to the same zone for which the water resources are being abstracted. For some projects this may cover multiple water resource zones. The definition of water neutrality used will be as follows:

> *For every new development, water demand should first be minimised then any remaining water demand offset, so that the total demand on the public water supply in a defined region is the same after development as it was before.*

[7]Therivel, Riki, Christine Drury, and Ian Hepburn, comps. Achieving Water Neutrality in the South East Region Discussion Paper. (Oct. 2006).
[8] Environment Agency (2009), Delivering water neutrality: measures and funding strategies, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291739/scho1009bqzt-e-e.pdf
[9] Waterwise (2008), Water neutrality discussion paper, https://www.waterwise.org.uk/wp-content/uploads/2018/02/Copy-of-Water-Neutrality-Discussion-Paper.pdf

3. Water Neutrality in Practice

There are three steps to achieving water neutrality; (1) reducing water use by making the new build as water efficient as possible, (2) installing water reuse systems, such as rainwater harvesting or grey water recycling and, (3) offsetting any remaining demand in the existing local region.

Water neutrality should be achieved over a set period, such as 10 or 20 years, and assessed at various stages of the build (e.g. planning and design, as constructed, and ongoing monitoring once the homes have been built and are occupied). Note, that water efficiency measures may deteriorate over time, so may need ongoing maintenance or replacement in order to maintain water neutrality.

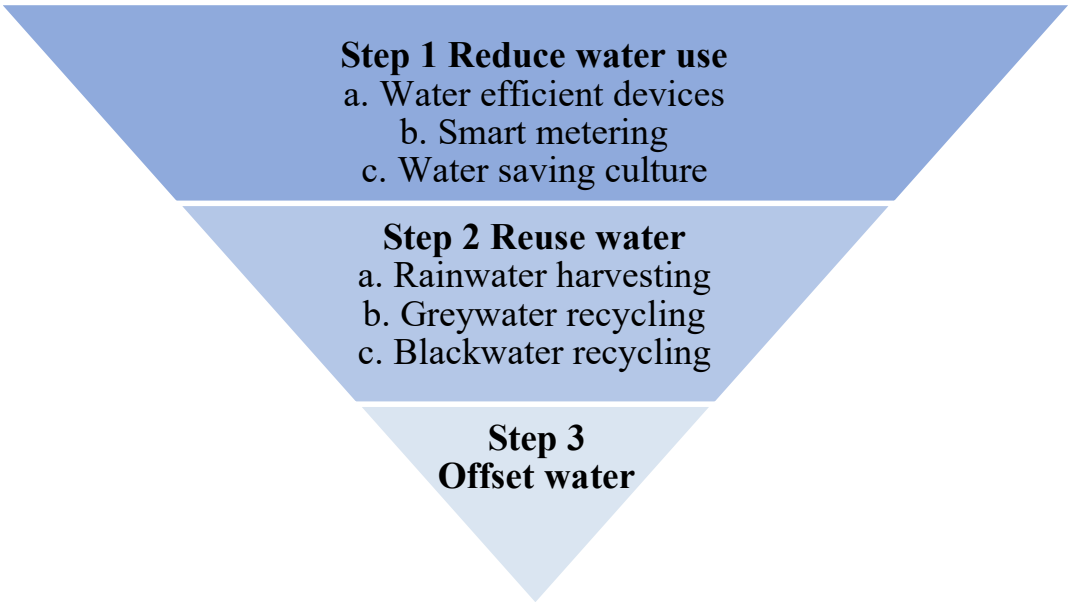

Figure 1 - Water Neutrality Hierarchy

3.1 Reducing Water Use

The first and most important step to achieving water neutrality is to ensure that water is used as efficiently as possible. This is done by fitting homes with efficient products and designing them to encourage water saving behaviours. The smaller the water demand of a building due to its design and fittings the less water is needed to be reused and offset.[10]

Water efficient devices include aerated taps and shower heads, low flush or air flush toilets and efficient white goods (i.e. dishwashers and washing machines). A mandatory water efficiency labelling system for water using products, similar to the scheme already in place for energy using products, would enable quick and easy identification of the most efficient water appliances and underpin minimum product and building design standards. Unfortunately, a water label is not yet in widespread use, as it is not mandatory in the UK for products to be tested and for a label to be displayed at the point of sale. Research carried out in England, Scotland and Wales provides compelling evidence that a mandatory water label tied to minimum product standards would be the most cost-effective way to reduce water consumption in the UK.[11]

Research shows that for a domestic building it might be possible to reduce demand to as little as 49 litres per person per day with technologies such as waterless toilets, recycling showers, smart taps,

[10] For the purpose of this report, we have taken a more realistic medium scenario of 80L for our various calculations.
[11] EST (2019) Independent Review of Water Labelling in the UK https://www.waterwise.org.uk/wp-content/uploads/2019/02/Water-Labelling-Summary-Report-Final.pdf

waterless washing machines and the use of non-potable water.[12] However, more realistically, a report by ETS looking at the impact of a labelling scheme in Wales states that houses can be designed down to 95 l/p/d cost effectively using products for the domestic market that are already commercially available and to 85 l/p/d using the best commercially available products.[13] A per capita consumption (PCC) of approximately 85 litres a day can be achieved by installing water efficient fittings, changing behaviours, such as not leaving the tap running when brushing teeth, using eco settings on the washing machine and dishwasher and by using a water butt in the garden.[14]

Water demand can also be reduced through fitting meters, (especially smart meters, which measure water usage and provide regular (usually hourly) readings to the customer), helping to identify leaks and tracking water consumption. Meters can help support and encourage behavioural change by showing homeowners their water usage and cost, and the impact of changing behaviour.

Getting buy-in from the householder to accept water efficient fittings and adopt good water saving behaviours in a new build home is also essential. Public awareness of why we need to save water and therefore install such water efficient fittings is low in the UK. A culture of water saving and understanding the value water resources will be critical to ensure devices are accepted and remain in place in the new home.

3.2 Water Reuse

Once water use is reduced to an ambitious level, water reuse should be considered. Water reuse generally refers to the capture, treatment (if required) and use of alternative water supplies for non-potable purposes. It includes rainwater and surface water harvesting, greywater recycling (typically the used water from baths, showers and hand basins) and wastewater recycling.

Water reuse technologies have the potential to save significant amounts of water. For example, 24% of water in the home is used for flushing the toilet and 4%[15] externally in the garden meaning a water reuse system could save at least a quarter of demand if it was installed for these purposes. Depending on its quality and the system installed it could also be used for an additional 12% of water for washing clothes.

Ricardo reported in 2020 on the costs and benefits of rainwater harvesting and greywater reuse and identified that in a range of settings the benefits outweigh the costs, particularly when wider societal benefits in terms of flood risk reduction and carbon reduction are considered.[16]

Tables 1 and 2 demonstrate the costs and benefits of different sized water reuse systems. They show financial benefits, especially for large developments and for society at large.

[12] Ofwat (2018) The Long-Term Potential for Deep Reductions in Household Water Use.
[13] EST (2019) Independent Review of Water Labelling in the UK https://www.waterwise.org.uk/wp-content/uploads/2019/02/Water-Labelling-Summary-Report-Final.pdf
[14] Ofwat (2018) The Long-Term Potential for Deep Reductions in Household Water Use. https://www.ofwat.gov.uk/wp-content/uploads/2018/05/The-long-term-potential-for-deep-reductions-in-household-water-demand-report-by-Artesia-Consulting.pdf
[15] Ofwat (2018) The Long-Term Potential for Deep Reductions in Household Water Use. https://www.ofwat.gov.uk/wp-content/uploads/2018/05/The-long-term-potential-for-deep-reductions-in-household-water-demand-report-by-Artesia-Consulting.pdf
[16] Independent Review of Costs and Benefits of RWH and GWR in the UK, Ricardo Energy and Environment, 2020 https://www.waterwise.org.uk/knowledge-base/independent-review-of-costs-and-benefits-of-rwh-and-gwr-options-in-the-uk/

Table 1 – Range of costs and benefits for installing RWH based on the collection area of a residential building[17].

Collection area	Example building types	Costs: CAPEX + OPEX ('000 £)	Water cost savings ('000 £)	Private net benefits ('000 £)	Societal benefits ('000 £)	Total net benefit ('000 £)
Small (<500m^2)	Standalone dwellings, Houses, Bungalows;	£12 - £19	£1 - £19	-£9 - £26	£21 - £77	**£10 - £100**
Medium (500 – 2000m^2)	Some larger houses or two semi-detached houses;	£25 - £38	£8 - £200	-£17 - £150	£50 - £163	**£35 - £340**
Large (2000 – 5000m^2)	Row of terraced houses or blocks of flats;	£20 - £35	£7 - £150	-£15 - £120	£35 - £335	**£20 - £450**
Very Large (>5,000m^2)	Large scale residential developments (including hybrid developments)	£35 - £60	£70 - £340	-£17 – £280	£30 - £920	**£14 – £1,200**

Table 2[18] - Costs and benefits of installing a GWR system in a building based on the system's yield.

Yield	Example building types	Costs (CAPEX + OPEX; '000 £)	Total water cost savings ('000 £)	Private net benefits ('000 £)	Societal benefits ('000 £)	Total net benefit ('000 £)
Low (<500m^3)	Smaller households (such as retired people or young adults), small commercial shops.	£ 45	£ 5	-£ 40	2	**-£ 37**
Small (500 – 1,500m^3)	Larger households (potentially families).	£ 100	£ 52	-£ 48	£18	**-£ 30**
Medium (1,500 – 4,000m^3)	Retail and commercial stores, leisure centres, some offices.	£ 120	£ 108	-£ 13	£34	**£ 25**
Large (4,000 – 10,000m^3)	Large commercial settings such as shopping centres, multi-unit offices or flats.	£ 170	£ 190	£ 21	£67	**£ 88**
Significant (>10,000m^3)	High rise offices or blocks of flat, hotels, multi-purpose developments.	£ 270	£ 780	£ 510	£275	**£ 787**

The supply and demand balance for the individual building or development needs to be considered in order to choose the correct type of system. For example, the demand for non-potable water, the required security of supply, and the volume of water that can be captured for reuse (e.g. considering rainfall patterns and catchment area for RWH, or the volume of greywater produced for GWR). Other factors such as site characteristics, scale of the system, and water quality requirements may also influence the selection of the system and its configuration. A building that produces a lot of greywater

[17] Independent Review of Costs and Benefits of RWH and GWR in the UK, Ricardo Energy and Environment, 2020 https://www.waterwise.org.uk/knowledge-base/independent-review-of-costs-and-benefits-of-rwh-and-gwr-options-in-the-uk/
[18] Independent Review of Costs and Benefits of RWH and GWR in the UK, Ricardo Energy and Environment, 2020 https://www.waterwise.org.uk/knowledge-base/independent-review-of-costs-and-benefits-of-rwh-and-gwr-options-in-the-uk/

and has a small roof surface area (like a hotel or a block of flats) might be better suited to a GWR system. But a building or development with a large catchment area (whether that be a roof or runoff from the wider development) might be best suited to RWH or surface water harvesting.

Sydney - Barangaroo, The Water Positive Region

Australia is famous for its severe droughts and lack of water supply[19] which means they have a wealth of case studies for water reuse and water neutrality. It also means that the general public are acutely aware of the impact of water use and are more supportive of innovative approaches. There is more pressure on government, developers and water companies to collaborate on these issues and it is common custom to have rainwater harvesting system in the home.

A region of Sydney called Barangaroo is home to an exciting urban renewal project aiming to become the first carbon neutral and water positive region. Led by urban developers and the City of Sydney, the project will host 3,000 residents and 23,000 office workers. Whilst the project aims to reduce water usage through water saving appliances and promoting water saving, they are aware there will be additional water usage that cannot be prevented, so all water used and produced on the site will be recycled. The greywater and blackwater will be captured from toilets, showers, laundries, waste rooms and restaurants, and additional water will be sourced from rainwater harvesting, cooling tower backwash, and from water mined from Sydney Water's sewer main.[20]

3.3 Offsetting

Finally, the remaining water requirement for the new home or development which can't be satisfied with non-potable sources needs to be offset. This can be done by investing in schemes that save water in the local region such as retrofitting existing buildings with water efficient devices or water reuse systems. The water saved through these schemes needs to be equal to the residual mains water usage of the new development in order to achieve water neutrality. The offset schemes also need to be within the same water resource zone as the new development (refer to your water company for more information on water resource zones).

[19] Barangaroo (2015), Sustainability https://www.barangaroo.com/the-project/progress/sustainability/
[20] Guardian Article on Barangaroo (2019) https://www.theguardian.com/sustainable-business/2016/sep/05/barangaroo-sydneys-largest-urban-renewal-project-aims-to-recycle-more-water-than-it-uses

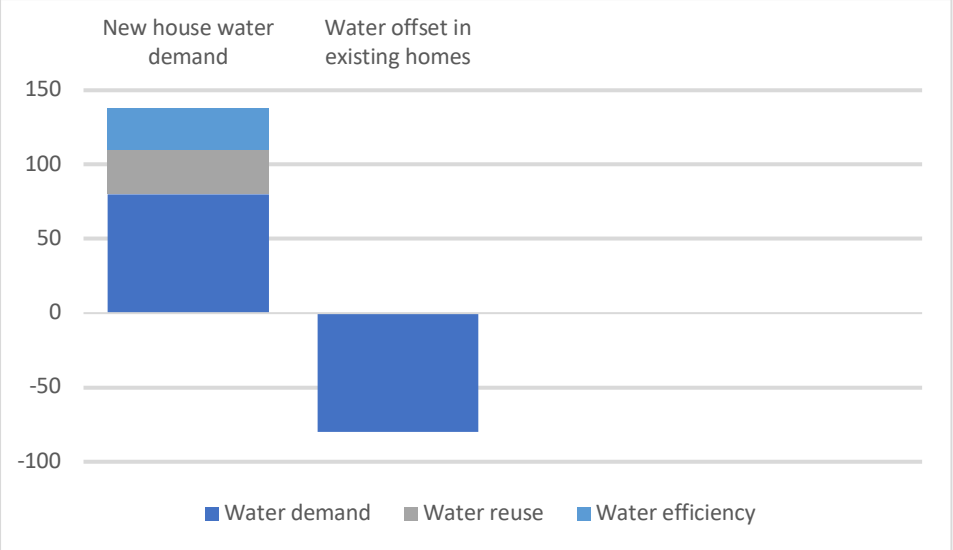

Figure 2 - Water Offsetting (based on average water demand of 138 litres per person per day in a new home)

For example, as shown in Figure 2, if the PCC of a new house was 138 litres, water efficiency and water reuse measures could reduce water to a PCC of 80 litres, then the last 80 litres could be offset by saving water in existing homes and buildings, bringing the overall water demand impact to zero.

Offsetting is usually carried out in partnership with other organisations, like a water company, council, businesses or charity. Some options for offsetting schemes are as follows:

- Funding water efficiency audits and retrofits for existing homes (e.g. through water companies) or for existing businesses.
- Donating/paying a fee to a housing association to retrofit their homes.
- Offsetting by retrofitting school buildings to improve water efficiency.
- Reducing leakage such as in schools, public buildings, businesses or homes (note, the offsetting through reducing leakage should not include planned works by water companies)

Retrofitting water reuse schemes such as in public buildings or schools. The offsetting activities should be supported by awareness campaigns and promoting water saving behaviours. The installation of smart meters can also help encourage water saving behaviours, and provide information on how much water is being used. The cost of offsetting will vary depending on the method used and total water footprint of the new building. A household audit typically costs between £48 - £100[21] per house and would achieve a saving of approximately 30-40 litres per home per day[22]. If the new home was built efficiently, to the ambitious level of 80 litres per person per day, and there was an occupancy of 2.23[23], it would require approximately 5 home retrofits to offset the new home, costing a total of £240 - £500. If the new home was built to an efficiency level of 110 litres per person per day, it would require approximately 7 home retrofits to offset the new build, costing £336-£700.

Non-domestic buildings can also be retrofitted to generate offsetting savings as well as reducing leakage (beyond water company planned works). This may be particularly relevant for larger scale developments or site locations where the number of homes in the region available to be retrofit is limited. There may be certain cases where water neutrality of a sizeable development isn't possible, because the amount of water cannot be offset in the same water resource zone. Assessments should therefore be carried out to measure the offset potential of a development, and options to firstly reduce water use explored.

[21] Based on average costs from Welsh Water, Thames Water, Southern Water and Brighton Council.
[22] Based on average savings from Thames Water and Southern Water.
[23] Based on average occupancy for UK 2020-21 - WRMP predicted figures from water companies.

Table 3 – Practical Summary of the 3 Steps

Step 1: Reduce Water				
Toilets	Cistern displacement devices (toilet hippos)	Retrofit flush devices to dual flush	Fix leaky loos	
Taps	Tap inserts (aerators)	Low flow restrictors	Push taps	Infrared taps
Showers/Baths	Low flow shower heads (less than 8 litres/min)	Shower timers	Reduced bath frequency & volume	
Outdoors	Hosepipe flow restrictors	Hosepipe siphons	Water butts	Mulches and composting to keep soil moist
Smart Metering	Leakage information	Encourage behavioural change	Innovative tariffs	Savings estimates
Water Saving Culture	Promotional campaigns	Self-audits	Education in schools	Posters/ leaflets/ websites
Step 2: Reuse Water				
Rainwater Harvesting	Small scale water butt	RWH system for individual homes and buildings	Large scale surface water harvesting	
Greywater Recycling	Small systems for individual homes	Larger scale systems for commercial and mixed-use sites		
Step 3: Offsetting Water				
Offsetting	Carry out retrofits	Funding a partner to carry out retrofits	Finding and fixing leaks	

4. Benefits

The benefits of water neutrality are wide ranging, from financial and reputational through to environmental and social. For a new domestic building they could include:

- **Saving water** – around 112,000 litres could be saved every year for each water neutral home built[24]. If all new housing developments in England were built to be water neutral over the next 10 years, we would see savings of approximately 691 Ml/d (million litres per day) in 2030.
- **Saving carbon** – around 43.8 $kgCO_2$ equivalent per year per household could be saved on carbon emissions arising from water supply[25]. Based on the number of new builds predicted in England, by 2030 we would be seeing carbon savings from reduced water supply of around 0.11 $MtCO_2$ equivalent per year in 2030. If emissions from using water in the home are considered the savings could be around 20 times higher.
- **Saving money** – annual savings on water and energy bills of around £44 per home can be achieved from reducing water demand in the home to 85 litres per person per day[26], for those on a meter. Coupled with this, if the house was part of a community scale water reuse system, there could be further financial savings over the 25-year life span of the system.[27] Additionally, any existing homes retrofit to offset the new home would benefit from reduced water bills of around £29 a year.[28]
- **Reducing environmental impact** by decreasing the amount of water abstracted from rivers and groundwater sources.
- **Improving resilience** for the future by minimising the additional pressure on water resources and networks.
- **Enabling future housing growth** in water scarce areas by reducing the impact of new homes and buildings on the water environment, and preventing water resources being a constraint to growth.
- **Reducing the amount of water going into the sewage network** by using less water, recycling grey water and rainwater harvesting.

4.1 Saving Water

Water consumption has doubled per person in the last 60 years and we have an additional 17 million people in the UK.[29] Reducing the burden new developments and existing buildings have on our mains water supply is crucial to ensure we are resilient and can accommodate future growth and a changing climate.

Around 112,000 litres could be saved every year for each water neutral home built[30], and if all new housing developments in England were built to be water neutral over the next 10 years, we would see savings of approximately 691 Ml/d (million litres per day) in 2030. In 2018, demand for water used in households across England and Wales was approximately 8400 Ml/d (which makes up 55% of the

[24] Based on personal consumption in a new home of 138 litres/person/day and occupancy of 2.23
[25] https://www.water.org.uk/wp-content/uploads/2019/12/Water-UK-Research-on-reducing-water-use.pdf - Based on there being 0.12$kgCO_2$ embedded in the production of water delivered to an average home per day multiplied by 365 days.
[26] Based on figures for 85liters from England from the Labelling Report – EST 2019 https://waterwise.org.uk/wp-content/uploads/2019/10/WEStrategy001EXT_TechnicalReport_2.4.pdf
[27] Independent Review of Costs and Benefits of RWH and GWR in the UK, Ricardo Energy and Environment, 2020 https://www.waterwise.org.uk/knowledge-base/independent-review-of-costs-and-benefits-of-rwh-and-gwr-options-in-the-uk/
[28] Based on figures for 110liters from England from the EST (2019) Independent Review of Water Labelling in the UK https://www.waterwise.org.uk/wp-content/uploads/2019/02/Water-Labelling-Summary-Report-Final.pdf
[29] Ofwat (2018) The Long-Term Potential for Deep Reductions in Household Water Use. https://www.ofwat.gov.uk/wp-content/uploads/2018/05/The-long-term-potential-for-deep-reductions-in-household-water-demand-report-by-Artesia-Consulting.pdf
[30] Based on personal consumption in a new home of 138 litres/person/day and occupancy of 2.23

whole distribution input).[31] Therefore, the potential saving if all new homes were built to be water neutral could make an 8% reduction on total household demand. The National Infrastructure Commission's Planning for a Drier Future[32] recommended that around one third of the extra 4,000 Ml/d needed by 2050 to ensure long- term resilience in England should come from demand management interventions. Water neutrality could provide approximately 17% of this deficit.

If non household developments were also to be water neutral this could provide even more of this deficit amount.

Table 4 – Potential Water Savings[33]

Water Neutral Scenario	**Water Saving**[34]
A water neutral new home (assuming building regulations require a PCC* design standard of 110 litres/person/day)	90,000 litres annual saving per water neutral home
A water neutral new home (assuming average water use with a PCC* of 138 litres/person/day)	112,000 litres annual saving per water neutral home
All new homes in England water neutral – savings being seen in year 10	691 megalitres per day (Ml/d) savings
All new homes in England water neutral – total water saved over 10 years	Total saving of 1.4 Billion megalitres or 1,400,000,000,000,000 litres[35]
All new homes in England water neutral – savings being seen in year 20	1500 Ml/d
All new homes in Thames Water area water neutral – savings being seen in year 10	147 Ml/d
All new homes in Thames Water area water neutral – savings being seen in year 20	330 Ml/d
All new homes in Anglian Water area water – savings being seen in year 10	83 Ml/d
All new homes in Anglian Water area water neutral – savings being seen in year 20	160 Ml/d
All new homes in Southern Water area water neutral – savings being seen in year 10	32 Ml/d
All new homes in the Southern Water area – savings being seen in year 20	68 Ml/d
All new built homes in Scotland water neutral-savings being seen in year 10	29 Ml/d
All new homes in Scotland water neutral – savings being seen in year 20	48 Ml/d

**PCC (per capita consumption) is the daily water consumption per person*

4.2 Saving Carbon

Mains water comes with a carbon footprint due to its treatment and transport to our homes and businesses. In total, water use accounts for 6% of UK greenhouse gas emissions (CO_2e)[36] with 89%

[31] Ofwat (2018) The Long-Term Potential for Deep Reductions in Household Water Use. https://www.ofwat.gov.uk/wp-content/uploads/2018/05/The-long-term-potential-for-deep-reductions-in-household-water-demand-report-by-Artesia-Consulting.pdf
[32] National Infrastructure Commission (2018) Planning for a Drier Future https://nic.org.uk/app/uploads/NIC-Preparing-for-a-Drier-Future-26-April-2018.pdf
[33] Figures taken from data provided from the EA which summarises WRMP predictions from water companies.
[34] Figures taken from WRMP estimated occupancy rate, new development predictions, PCC predictions.
[35] Total accumulative savings over ten years in litres.
[36] ETS (2013) At Home with Water https://energysavingtrust.org.uk/policy-research/home-water

of this footprint from heating water in our homes. Around 20% of a typical household gas bill is due to heating water in the home.[37] As outlined in Table 5, Artesia[38] has calculated that at a water consumption of 138 litres per person per day the total carbon emissions per household from water use is around 2.64 kgCO_2e/day (around 1 tonne CO_2e/year). This 2.64 kgCO_2e/day figure is based on water delivered to the home (0.12 kg); water heated in home, for hot water (1.30 kg); water heated by electric showers (0.78 kg); by washing machines (0.26 kg); by dishwashers (0.16 kg); and from managing wastewater (0.05 kg). On this basis, even a very modest 5-6% reduction in water consumption could deliver around 50 kgCO_2e saving per household in a year or 1.4 MtCO_2e per year based on 27.8 million households in the UK.[39] It should be noted that emissions from water heated for "central heating" or space heating are not included in the figures above as these systems are largely non consumptive.

Table 5 - Calculated carbon emissions due to household water use[40]

Per capita consumption (l/p/d)	**Carbon emissions per property (kg CO_2e)**
138	2.64
130	2.51
120	2.34
110	2.19
100	2.10
90	1.87
82	1.74

If a new build home was water neutral, it would save greenhouse gas emissions from the 'delivered water' to the home as well as from heating less water in the home. Around 43.8 kg CO_2 equivalent per household could be saved a year (based on there being 0.12 kg CO_2 equivalent embedded in the production of water delivered to an average home per day[41]).

On this basis, a 10,000 house property development which was built water neutral would save 1.2 tonnes of CO_2e a day, based on removing emissions from the supplied water. If we include potential greenhouse gas savings for water use in the development the savings would be over 20 tonnes of CO_2e a day or 7,300 tonnes in a year.

Table 6 – Carbon Savings (based on Artesia's 0.12 kg and 2.64 kg CO_2e per property per day for water supply and overall, respectively)

Water Neutrality Scenario	**Carbon Saving**
All new homes water neutral, after 10 years in England	0.11 MtCO_2e per year – just from delivered water
All new homes water neutral, after 10 years in England	2.49 MtCO_2e per year – from delivered water and water use in the home.

20-year calculations not included because UK energy supplies should be decarbonised by then.

[37] ETS (2021) Why We Should all be Saving Water? https://energysavingtrust.org.uk/home-energy-efficiency/saving-water
[38] Ofwat (2018) The Long-Term Potential for Deep Reductions in Household Water Use. https://www.water.org.uk/wp-content/uploads/2019/12/Water-UK-Research-on-reducing-water-use.pdf
[39] Office of National Statistics (2019) Families and Households in the UK https://www.ons.gov.uk/releases/familiesandhouseholdsintheuk2019
[40] Ofwat (2018) The Long-Term Potential for Deep Reductions in Household Water Use https://www.water.org.uk/wp-content/uploads/2019/12/Water-UK-Research-on-reducing-water-use.pdf
[41] Ofwat (2018) The Long-Term Potential for Deep Reductions in Household Water Use https://www.water.org.uk/wp-content/uploads/2019/12/Water-UK-Research-on-reducing-water-use.pdf

For comparison, the total carbon savings seen in the whole UK residential sector in 2017-18 and in 2018-19 were around 1.2 $MtCO_2e$. Water neutrality could make a big step towards reducing our domestic carbon emissions and to enable the water industry to achieve its target of reaching net zero by 2030.

Water UK's Net Zero 2030 Routemap[42] sets out the water industry's vision for how water companies will play their part in tackling climate change and reach net zero by 2030, two decades ahead of the UK Government's legally binding target of 2050. Water neutrality could play a part in achieving this target by slowing the increase in water demand, and subsequent operational carbon emissions, predicted over the next decade.

4.3 Saving Money

To the new homeowner, a key benefit of water neutrality is lower water bills, due to less water consumption, (in England and Wales, all new homes are built with meters installed, but this is not the case in Scotland). Water neutral housing developments should be designed to be exceptionally water efficient, for example the Ofwat/Artesia (2018) Report which models potential reductions in water demand, claims that a per capita consumption (PCC) of 49 litres per person per day is possible to achieve in new build homes[43], with a more realistic figure being around 85 litres. Achieving this low level of consumption would result in very low water bill payments if on a meter.

Annual savings on water and energy bills of around £44 per home can be achieved from reducing water demand in the home to 85 litres per person per day.[44] Coupled with this, if the house was part of a community scale water reuse system, there could be further financial savings over the 25-year life span of the system.[45] Additionally, any existing homes retrofit to offset the new home would also benefit from water and energy bills being reduced by around £15.50 a year.[46]

4.4 Reducing Environmental Impact

Water neutrality has a number of environmental benefits, which can help reduce the impact of new developments. For example, less water needing to be abstracted from rivers and groundwater sources and reduced carbon emissions from treatment and transport of water as highlighted above.

Pressures on drainage systems and combined sewer overflows can also be reduced with a water neutral development discharging less water to sewers and potentially to surface drains than a standard development.

4.5 Improving Resilience

Reducing water use in new developments, as well as existing homes and buildings through offsets, can reduce the growing pressure on water resources and help build towards a more resilient water resource region.

[42] Water UK, Net Zero Route Map (2020) https://www.water.org.uk/routemap2030/
[43] Ofwat and Artesia Report (2018) The long term potential for deep reductions in household water demand. https://www.ofwat.gov.uk/publication/long-term-potential-deep-reductions-household-water-demand-report-artesia-consulting/
[44] Based on figures for 85 litres from England from the Labelling Report – EST 2019 https://waterwise.org.uk/wp-content/uploads/2019/10/WESTrategy001-EXT_SummaryReport_2.3-1.pdf
[45] Independent Review of Costs and Benefits of RWH and GWR in the UK, Ricardo Energy and Environment, 2020 https://www.waterwise.org.uk/knowledge-base/independent-review-of-costs-and-benefits-of-rwh-and-gwr-options-in-the-uk/
[46] Based on figures for 110liters from England from the Labelling Report – EST 2019 https://waterwise.org.uk/wp-content/uploads/2019/10/WEStrategy001-EXT_TechnicalReport_2.4.pdf

Alternative water supplies, such as rainwater, surface water and greywater, can provide local non-potable water supplies to help reduce reliance on mains water, especially for businesses who rely on water to operate. Reducing reliance on mains water and exploiting alternative sources means businesses will be less exposed to interruptions to supply in the future, improving their business resilience. There are encouraging examples of businesses choosing to become water neutral for these reasons. Businesses that invest in becoming water neutral benefit from the same long-term reduction in water bills, as well as the positive reputational gains from improving their environmental credentials. Water neutrality may also help support broader sustainability objectives for businesses, such as reducing energy use or reducing their impact on the environment, this is demonstrated in the Sainsbury's and Waterscan example.

Sainsbury's and Waterscan

Sainsbury's and their water retailer Waterscan started working together in 2011 to reduce Sainsbury's operational water consumption. By 2015 Sainsbury's had achieved 'triple neutrality' for carbon, water and waste in three of their stores.[47] To achieve water neutrality, they started by installing waterless urinals, dual flush toilets, and sensor taps. The demand for non-potable water was met using rainwater harvesting technology. In the Weymouth Gateway store the rainwater was enough to cover 70% of the store's water needs with the additional 30% being offset through local partners. The partners were then able to offset the water in schools in the local area. They estimate that each of these three stores save on average 25 million litres of water each year through this project and the offsetting saves around 18 million litres a year, enough to meet the consumption needs of 120 homes. Sainsbury's hope to reproduce this at more of their stores over the coming years and that other companies in the industry will follow suit.[48]

4.6 Enabling Future Housing Growth

The UK government has ambitious plans to end the housing crisis and build new homes[49]. Water neutrality can help enable future housing growth, particularly in areas of water stress or with environmental constraints, by reducing the impact of new developments on water resources. In parts of the east of England for example, there are cases of planning authorities potentially being unable to achieve higher levels of growth due to the constraint of scarce water resources. Creating a water neutral development can also help reduce the amount of waste water needing to be collected and treated, because less water is being used in both the water neutral homes and those retrofitted in the existing community.

A new development of 10,000 homes, with average occupancy of 2.23 people per home, could save around 2.8 million litres of water a day and greenhouse gas emissions savings of 1.2 tonnes CO_2e a day.

[47] Sainsbury's (2013) Neutral turns out positive https://www.about.sainsburys.co.uk/making-a-difference/our-values/our-stories/2017/neutral-turns-out-positive
[48] UNESCO-IHE, A.Y. Hoekstra (2008), Value of Water, Research report series no.28 https://ris.utwente.nl/ws/portalfiles/portal/5148071/Report28-WaterNeutral.pdf
[49] Tackling the Undersupply of Housing in England (2021) https://commonslibrary.parliament.uk/research-briefings/cbp-7671/

5. Barriers

Despite the many benefits of water neutrality, it has not yet seen wide-scale implementation in the UK. There are a number of potential barriers to uptake, including:

- **Potable water is cheap** creating little or no financial incentive for homebuyers to demand, and developers to install, water efficiency and water reuse measures.
- **Lack of targets and regulatory requirements** for water neutral development either nationally or locally in policy or the planning system.
- **Funding sources and mechanisms are unclear** with no specific funding or incentives allocated for water neutral development.
- **The focus on offsetting** to achieve neutrality rather than reducing consumption of mains water first.
- **Multiple delivery partners** creates complexities for planning and implementation.
- **Public awareness** of water resource issues are low, therefore desire to own and maintain a water neutral home may also be low.

5.1 The Price of Potable Water

The low price of water is a barrier to success for water neutrality. The price of potable water creates little or no financial incentive for homebuyers to demand, and developers to install, water efficiency and water reuse measures. Financial savings on water bills are very low compared to savings made by energy efficiency and carbon offsetting. Despite strong environmental benefits of water neutrality, developers, home buyers and ultimately water bill payers are not motivated enough by the potentially low savings. 2020 research on the costs and benefits of rainwater harvesting and grey water reuse demonstrates that the benefits of these systems fall to society generally and to the environment, rather than to the individual installer in financial payback[50] (see Tables 1 and 2 below). As the majority of the benefits are felt by society as a whole, rather than the individual installer, policies and incentives around water neutrality and water reuse systems should reflect this.

5.2 Lack of Targets and National Planning Policy

The concept of water neutrality has been with us since at least 2008 but has not yet become common practice in the way carbon neutrality, flood risk neutrality or biodiversity net gain have. These fields have either national targets (such as net zero carbon emissions by 2050), national planning policy or both.

National planning policy requires a developer to assess the flood risk of its development and take measures to ensure that any additional flood risk is addressed such that it does is not increased elsewhere and the development is effectively flood risk neutral.[51] Currently, developments are expected to minimise impacts on and provide a net gain for biodiversity. With the new Environment Bill expected to introduce a statutory requirement for all new developments which require planning permission to improve biodiversity by 10% and maintain it for at least 30 years.[52] There is no such national or international target in place for water efficiency or water neutrality.

Beyond planning policy, other policy or regulatory requirements to drive high levels of water efficiency and water neutral development are limited. The Building Regulations for England (Part G) sets out a

[50] Independent Review of Costs and Benefits of RWH and GWR in the UK, Ricardo Energy and Environment, 2020 https://www.waterwise.org.uk/knowledge-base/independent-review-of-costs-and-benefits-of-rwh-and-gwr-options-in-the-uk/
[51] https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications
[52] DEFRA (2018) Net Gain Consultation Proposals https://consult.defra.gov.uk/land-use/net-gain/supporting_documents/netgainconsultationdocument.pdf

mandatory water efficiency standard for new homes of 125 litres per person per day, or an optional higher standard of 110 litres per person per day where a 'clear local need' can be demonstrated through the preparation of local plans[53] (this is compulsory throughout Wales). Even the more ambitious target is a long way from achieving the impact of water neutrality.

In fact, the National Planning Policy Framework (NPPF) contains an explicit barrier to water neutral development. That is because the NPPF[54] prevents planning authorities from setting a more ambitious water efficiency standard than 110l/p/d by stating it should be consistent with the Government's national policy for national technical standards[55]. In effect planning authorities have to demonstrate, to the satisfaction of a Planning Inspector, that the higher standard of 110/l/p/d is justified by the available evidence and does not make the plan or individual developments unviable.[56] Any attempt to impose a more demanding standard would be rejected by the Planning Inspector as being inconsistent with national planning policy.

5.3 Funding Sources

Funding is a crucial barrier to delivering water neutral projects as there is currently no specific funding mechanism and it will likely require various funding sources[57]. In the recently approved Greater Brighton water neutral pilot project, it is estimated that each audit to offset water at an existing home will cost between £70 and £100, therefore the total cost to offset the water needed for each new home being in the region of £371 and £870.[58]

Water neutrality pilot project – Greater Brighton, UK
In July 2020 the Greater Brighton Economic Board announced its support for a package of work linked to a green growth recovery, with a particular focus on energy and water efficiency.[59] The programme of work includes a project focusing on achieving water neutrality in the region by 2030. The project will start with an initial pilot, where it is proposed that developers will be asked to contribute to the offsetting cost for sites over 10 dwellings. The offsetting will include water saving home visits in the existing community, which are undertaken by the water company and cost between £70 and £100 per visit. It is estimated that the cost of offsetting the new water demand will be from £371 to £870 per dwelling, depending on the level of water efficiency of the new home.[60]

The council of Santa Monica in California, home to nearly 100,000 residents, has put an ordinance in place that requires any new development to offset its water use onsite.[61] The cost of this will fall to developers and when the development cannot reach neutrality on site they are required to pay a fee to the council which will be used for retrofitting schemes (in the same way that developers might be expected to contribute toward new flood defences for a community if the new homes add to local levels of flood risk). In these examples, developers have funded the extra cost, but local authorities and water companies are also potential funders and definitely potential partners.

[53] Para 170 of the National Planning Policy Framework February 2019
[54] Para 150 of the National Planning Policy Framework February 2019
[55] https://www.gov.uk/government/speeches/planning-update-march-2015
[56] MHCLG (2015) Housing: Optional Technical Standards https://www.gov.uk/guidance/housing-optional-technical-standards#water-efficiency-standards
[57] Environment Agency (2009), Delivering water neutrality: Measures and funding strategies
[58] Greater Brighton Water Plan - Draft (July 2020), https://present.brighton-hove.gov.uk/documents/g9985/Public%20reports%20pack%2014th-Jul-2020%2010.00%20Greater%20Brighton%20Economic%20Board.pdf?T=10
[59] Greater Brighton (July 2020), Water and energy projects unveiled by Greater Brighton to combat climate change and trigger "Green Growth" recovery, https://greaterbrighton.com/water-and-energy-projects-unveiled-by-greater-brighton-to-combat-climate-change-and-trigger-green-growth-recovery/
[60] Greater Brighton Water Plan - Draft (July 2020), https://present.brighton-hove.gov.uk/documents/g9985/Public%20reports%20pack%2014th-Jul-2020%2010.00%20Greater%20Brighton%20Economic%20Board.pdf?T=10
[61] Santa Monica City Council (2017) Water Neutrality Ordinance https://www.smgov.net/uploadedFiles/Departments/OSE/Categories/Water/Ordinance_2545CCS.pdf

5.4 Focus on Offsetting

Water neutrality, and other neutrality concepts, have faced some criticism for putting too much attention on offsetting rather than reducing initial water demand. A focus on offsetting doesn't drive the ambition towards water efficiency measures in new builds, rather the assumption that any demand can be offset. This has been a weakness for the biodiversity net gain agenda. BirdLife International[62] has identified numerous developments in Europe that were permitted on highly valuable wildlife sites with the promise of offsetting elsewhere. Similar stories exist around carbon offsetting being used to justify unsustainable developments.

As discussed, offsetting needs to link to the same water resource zone for which the water resources are being abstracted. Further discussion is needed to agree whether checks and approvals would be needed to measure or certify water neutrality and which authority would issue such approvals, if any. Additionally, the ongoing ownership and responsibility for maintaining water reuse systems and water efficiency devices needs to be determined, to ensure performance still meets water neutrality over time.

5.6 Multiple Delivery Partners

Neutrality projects often can involve multiple partners for delivery, with responsibilities between organisations being unclear. For example, the University of California faced various obstacles and barriers whilst trying to implement their own carbon neutral project in 2013, which they documented in detail in their 2018 evaluation report. They concluded that without proper planning across the partnering organisations it was difficult to address barriers such as a lack of buy-in, stranded assets, financing, a poor communications strategy, lack of operations management and overall planning.[63]

The nature of water neutrality means that the most successful projects from global examples are where partners join to work together successfully, for example; Sainsburys and Waterscan, South African Government and WWF, Developers and The City of Sydney.

5.7 Public Awareness

Research reveals that 46% of people believe their household uses under 20 litres of water a day, when it is actually 142 on average.[64] Public awareness of water use and water resource issues are very low in the UK, therefore the desire to own and maintain a water neutral home may also be low. The public perception may be that water neutral homes with rainwater harvesting systems and water efficiency devices in them would require more maintenance from specialist plumbers. Education and understanding are also key to ensure new home owners don't replace the water efficient devices that are in place.

However, research carried out by Waterwise in 2020 suggested that 87% of the 400 surveyed participants would be interested in having a rainwater harvesting system in their home.[65] Although when asked about possible reasons for not installing a water reuse system by far the biggest barriers were cost and maintenance.

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[62] http://www.birdlife.org, https://www.iucn.org/content/pros-and-cons-biodiversity-offsets
[63] Julia Forgie & Ann Carlson (2018) https://escholarship.org/content/qt34m0j8j6/qt34m0j8j6.pdf Case study - California University (a large scale project).
[64] Water UK, (2020) https://www.water.org.uk/news-item/vast-majority-of-brits-have-no-idea-how-much-water-they-use-each-day/
[65] Public Perceptions of RWH and GWR – Waterwise and GLA (2020) https://waterwise.org.uk/wp-content/uploads/2020/03/RWH-and-GWR-Public-Perceptions-Study-FINAL.pdf

Thames Gateway

The Thames Gateway project was an in-depth study that looked into water neutrality within this region of London to determine whether it could be achieved. The project was established in 2006 by the government whose aim was to identify if it would be possible to keep the total demand for water in the Thames gateway area the same between 2005 and 2016, despite having an extra 160,000 homes and 180,000 jobs.[66] The research found that an additional 42 megalitres a day would be needed in the region to meet the demand of the increased population and businesses. Therefore, to reach water neutrality this extra demand for water would need to be reduced and offset to get down to no additional demand. The possible options they found for offsetting the demand included metering, variable tariffs, water efficient new homes, retrofitting and efficiency audits of existing buildings. Their research found the most effective combination of techniques to reach 100% neutrality, showing that the project was indeed feasible but very ambitious. They found a combination of metering, tariffs, retrofitting and very efficient new builds was the second cheapest option. However good this project was in theory it never got off the ground and was not delivered. Funding, political and delivery barriers all resulted in this project not taking place at the time, although the Dartford Council have since strengthened their Water Management Policy.

[66] Environment Agency (2007) Towards water neutrality in the Thames Gateway https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291668/scho1107bnmc-e-e.pdf

6. Enabling Water Neutrality

Delivering water neutrality and encouraging wide scale uptake in new developments will require a number of supporting factors. These include funding sources and mechanisms, supporting policy and leadership, building awareness, and delivery partnerships.

6.1. Funding Mechanisms

Delivering water neutral development will likely require a range of funding sources and mechanisms. This will be particularly important for the offsetting component, given the multi-stakeholder approach that will be needed. The Environment Agency in their 2009 report on water neutrality highlights that a single source of funding is also unlikely to achieve the scale of water efficiency offsets required for water neutral development.[67] The following funding sources and mechanisms could be explored to deliver water neutrality.

- **Water company programmes –** Funding for water company programmes such as water saving and smart metering can support the delivery of water neutral development. Water efficiency measures can include water saving home or school visits, water efficient device giveaways, as well as education and awareness campaigns. The roll out of smart metering may also align with new development areas and help reduce water use in both new and existing homes. Water companies should know which properties have already received water efficiency retrofits.

- **Local Authority projects and offsets** – Local Authority-led projects and offset schemes can also help support the delivery of water neutral development. Local Authorities already work with a range of stakeholders involved in new development, and examples from flood risk, biodiversity and nutrient neutrality have shown how offsets can be delivered at a local level. The funding mechanisms could be through the infrastructure charges, such as the community infrastructure levy or Section 106 contributions, with projects either delivered directly by the Local Authority or indirectly through other organisations (e.g. water companies or local charities).

- **Market-based offsets** – Large scale marked-based schemes at a national or international level have been developed for carbon trading, such as the EU Emissions Trading System.[68] A more localised system would be required for water neutrality to ensure the offsets occur in the same water resource zone as the development. The nitrate trading platform in the Solent region in the UK is testing this type of approach at a local level, with potential lessons for water neutrality.

Nutrient neutrality and nitrate trading – Solent region, UK

The water environment in the Solent region is internationally significant with protected habitats and wildlife. The high level of nutrients (nitrogen and phosphorus) entering this environment was found to be causing eutrophication and impacting the protected habitats and bird species. With the nutrient sources mainly from agriculture and wastewater, and uncertainty about impacts from future growth in the region, Natural England recommended that new development achieve nutrient neutrality.[69] As a result, local councils introduced temporary measures in 2020 including requirements for developers to calculate nutrient budgets as part of the planning process, as well as options for offsetting additional nutrient loads. For example, Eastleigh Borough Council

[67] Environment Agency (2009), Delivering water neutrality: Measures and funding strategies
[68] UK Department for Business, Energy & Industrial Strategy (2013), EU ETS: Carbon Markets, https://www.gov.uk/guidance/eu-ets-carbon-markets
[69] Natural England (March 2020), Advice on achieving nutrient neutrality for new development in the Solent region, https://www.push.gov.uk/wp-content/uploads/2020/03/Advice-on-Achieving-Nutrient-Neutrality-for-New-Deveopment-in-the-Solent-Region-March-2020.pdf

introduced an option to offset nitrates against Council land with a charge of £4,500 per dwelling.[70] In September 2020, Defra announced £3.9 million funding to support the creation of an online nitrate trading platform, with the aim to enable housing growth whilst also protecting the environment from nitrates.[71] The platform will allow developers to buy credits for new habitat that will support wildlife as well as nitrate removal, using a market-based approach to offsetting. The roll-out of the platform is planned over the next two years.

- **Rebates and grants** – Financial incentives such as rebates or grants can help enable the uptake of water saving products, such as rainwater tanks, which could reduce water use in both new and existing homes. A number of water companies offer rebates to developers on connection charges for new development where it is particularly water efficient.

- **Energy efficiency** – Given the links between household water use and energy use there may be opportunities for joint funding of projects that seek to achieve both water and carbon neutrality, or where the reductions in water use also support energy efficiency objectives.

- **Innovation funding** – Innovation project funding offers an opportunity to deliver pilot projects and to develop a template for how water neutrality can be achieved in practice, particularly as the concept is still in the early stages and continues to develop. Innovation funding may also be relevant for the measures or components that are needed to reduce water use, such as development of water efficient products and devices. Opportunities may be available through water company innovation programmes or broader industry innovation funding.

6.2 Supportive Policy

Top-down supportive policy and leadership is necessary to take this agenda forward, as we have seen with carbon neutrality, flood risk and biodiversity. The UK Government, along with many local authorities, declared a climate emergency in 2019, which should create a more susceptible political and social environment for carbon cutting solutions such as water neutrality to be considered.

At a national scale, flooding policy demonstrates a potential model for water neutrality. Developers need to comply with Local Planning requirements which are in turn directed by National Planning Policy[72] to assess their additional flooding footprint of their development and then avoid, mitigate or offset it locally, often working with other stakeholders for this to be achieved. The process varies with the size of the development and the sensitivity of the location but the key principles are the same. The policy framework states that when determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere, and only consider development appropriate in areas at risk of flooding where informed by a site-specific flood risk assessment following various tests.

National policy to promote or require water neutrality could be considered along similar lines, potentially linked to the size of the development and the sensitivity of the water environment in which the site is located. In South Africa, the government has taken the lead with initiating and investing in large scale water neutral schemes, that work with businesses to offset their usage.

South Africa water neutrality scheme
The government in South Africa has led a water neutrality scheme in conjunction with WWF South Africa, and have laid out a 3-step plan to invest in water neutrality.[73] The government's plan says; that participants must review and measure their water use; corporations are then required to

[70] Eastleigh Borough Council (2020), Water Quality Issues in the Solent Catchment Area, https://www.eastleigh.gov.uk/planning-and-building/water-quality-issues-in-the-solent-catchment-area
[73] Nel, Marais and Blignaut (2009) Water neutrality: A first quantitative framework for investing in water in South Africa https://www.researchgate.net/publication/229858632_Water_neutrality_A_first_quantitative_framework_for_investing_in_water_in_South_Africa

develop and implement ambitious water reduction plans and strategies; these corporations are then required to invest in payment for watershed schemes that will make new water available into freshwater ecosystems and offsetting the corporation's water deficit. The aim of this scheme is to offset the 3,652 million m^3 of water used by industrial and urban users in South Africa.

In addition to national policy and central government, local councils could have an important role to play in driving water neutral development forward. While there are limitations within the local planning system on requirements for water efficiency and reuse, there are opportunities for local authorities to encourage developers to work with other stakeholders to consider water neutrality as part of the planning process for new development. Local plans could include a planning policy to this effect. For example, Dartford Borough Council's Water Management Policy (2011) encourages water efficiency, water reuse and ensures that new developments do not outstrip the water supply capacity. Unfortunately, when the Code for Sustainable Homes ended, the policy was changed, weakening the requirements.

Reading Climate Action Network (CAN), an organisation set up following the climate emergency status to move Reading toward the net zero carbon targets, acknowledges the part water neutrality can play in managing the use of water in the region. Reading is one of the most water stressed parts of the country with similar water availability per head to some communities in the Middle East. Reading CAN's Water Plan stipulates 'water neutrality as a planning requirement' which should be delivered with partners Thames Water and Reading Borough Council.[74]

Dartford Borough Council's Water Management Policy 2011[75]

In the Thames Gateway, Dartford Council will: a) Work with water companies and monitor development to ensure that new development and water services are co-ordinated and that the pace of development does not outstrip the water supply and waste water / sewerage treatment capacity at any time. b) Require all new homes to achieve at least level 4 of the Code for Sustainable Homes in terms of water use (105 litres per person per day) in advance of mandatory requirements. c) Sites of 500 units or more will be required to reduce dependence on potable water through rainwater harvesting, recycling of used water and reduction of water 'hungry' activity. d) Require all non-residential developments of 1,000 sqm and above to meet the BREEAM 'excellent' standards of water efficiency. e) Work with water companies and social landlords to fit existing homes and other buildings with more efficient devices and appliances; reduce leakage; and expand metering.

6.3 Education and Awareness

Awareness of water resource issues in the UK is extremely low and consequently there is little public pressure on government to implement approaches such as water neutrality, compared to other sustainability issues like reducing single use plastic or reducing carbon emissions. An increase in the general understanding of how precious water is to our lives and how fragile our water resources are in the UK would be very useful for this agenda. Likewise, an increased awareness of water neutrality and the role it could play in securing water supplies, enhancing the environment and saving money and carbon would help. Greater awareness amongst the public could encourage organisations to achieve water neutral status to meet public expectations. It would encourage developers to build

[72] https://www.gov.uk/guidance/flood-risk-and-coastal-change
[73] Nel, Marais and Blignaut (2009) Water neutrality: A first quantitative framework for investing in water in South Africa https://www.researchgate.net/publication/229858632_Water_neutrality_A_first_quantitative_framework_for_investing_in_water_in_South_Africa
[74] Reading Climate Action Network, Climate Emergency Strategy (2020) https://readingcan.org.uk/wp-content/uploads/2020/10/our-plan-READING-CLIMATE-EMERGENCY-STRATEGY-2020-25-Final.pdf
[75] Dartford Borough Council's Water Management Policy CS25 (page 90) https://windmz.dartford.gov.uk/media/Inspector%20Approved%20Core%20Strategy.pdf

water neutral homes as they would sell faster because buyers would understand the implications for lower bills and their local environment.

Public education and awareness are essential to promote water saving behaviours and to ensure that water efficiency and reuse measures are effective in the long term. While it is important that homes are built to the highest water efficiency standards, achieving water neutrality will also be dependent on how water is used within the home after it is built. Water efficiency and reuse measures should be supported by education and awareness about the importance of and how to save water upon purchase of a water neutral home. Channels of support for maintenance and information would need to be established to ensure continued performance of the devices and systems in the long term. Water companies have ongoing campaigns to increase awareness around water efficiency, especially in the dry summer months, however it would need to be considered which organisation would be best suited to provide ongoing support and maintenance to ensure it continues to deliver savings which make the building neutral.

6.4 Business Resilience

Businesses rely on water to operate for the welfare of their staff, manufacturing processes and other operational needs. Most businesses are making commitments to reduce their environmental footprint. This is often in terms of setting themselves goals to reduce energy use, carbon, water, plastic or to promote biodiversity. A number of businesses have set themselves a target of water neutrality, for example Sainsbury's (see earlier) and Microsoft. At Microsoft's Silicon Valley campus in California, they have committed to achieving water neutrality[76]. This commitment is the first of its kind in Silicon Valley and to achieve it Microsoft have fitted low flow fixtures, wastewater recycling facilities for reuse in irrigation and toilets and other water saving appliances.

In addition to individual companies some sectors are committing to water neutrality. For example, India is severely impacted by droughts and the cement industry, one of the most water intensive industries in India, has become water neutral[77] to protect from future interruptions to business caused by droughts. They achieved this by reducing water use through new technology with any remaining water use offset through harvesting and demineralising water from mining pits. The cement industry has successfully managed to reach water neutrality and they now aim to become 20 times water positive by 2025.

Businesses are often the first movers on environmental ideas, particularly where they directly impact business operations. As more businesses adopt water neutrality it could help drive the approach towards becoming mainstream.

6.5 Good Partnerships

Learning from all areas of neutrality in the UK and global examples, it is clear that good partnerships between key organisations are very important. Water neutrality also needs a multi-stakeholder approach, particularly with the offsetting component, so establishing strong partnerships early in the development process is crucial. The stakeholders may include water companies, local authorities, developers, and other local organisations and businesses. As a starting point, the developer, local authority and water company should discuss ambitions to achieve water neutrality in the very early stages of a development.

[76] Henretig (2017) Building the first net zero water campus in Silicon Valley https://blogs.microsoft.com/green/2017/12/05/building-first-net-zero-water-campus-silicon-valley/
[77] Varghese (2020) Water Neutrality for a sustainable future - India Cement Magazine https://indiancementreview.com/feature/water-neutrality-for-a-sustainable-future/117192

Biodiversity net gain – Aylesbury development
A successful large-scale development of 2,500 homes near Aylesbury achieved biodiversity net gain, as well as protecting homes, businesses and critical infrastructure from flooding and storm events. This was achieved through strong partnerships with Barratt Developments, the RSPB, Southern Ecological Solutions and Aylesbury Vale District Council[78]. The development managed to achieve a biodiversity net gain through extensive planning and surveys of the local ecology prior to building which allowed the developers to prevent any unnecessary damage to the biodiversity. Any damage that was done was offset by improving biodiversity locally through habitat creation, restoration of arable fields, wetlands, grasslands and the formation of a new nature reserve.

7. A Worked Example

Using the example of a single new domestic building Table 7 works through the costs and savings made throughout the three stages: reduce usage, water reuse and offsetting. Two scenarios have been considered. In the first, the new build home has an efficiency equivalent to a per capita consumption level of 110 litres per person per day which is required in Wales and can be applied by planning authorities within "water stressed" areas of England. In the second, the home has a more ambitious design standard of 82 litres per person per day. It should be noted that the additional cost of building a house at 110 litres per person per day (versus the national default standard of 125l/p/d) is around £13.70 and for 85 the additional cost is £17.10.[79]

Table 7 – A worked example to demonstrate some of the costs and benefits of water neutrality applied to one house.

Step	Calculation	Standard Home (PCC of around 110)	Ambitious Home (PCC of approx. 82[80])	Assumptions
Annual water demand of a typical non water neutral new build property		115,851 litres	115,851 litres	Assuming 2.23 person occupancy and PCC of 138 l/p/d
1 – Water Efficiency Measures	Annual water saving from efficiency measures	23,506 litres	46,173 litres	
	Annual money saved by householder on water and energy bills	£29	£44	These figures have been drawn from the Phase 2 Water Labelling Technical Report table 14
	Annual carbon saving from efficiency measures	164.25 $kgCO_2e$	328.5 $kgCO_2e$	These figures are drawn from Artesia's PCC pathways report to Water UK section 3.4.2.
2 – Water Reuse	Water reuse systems could bring the water demand of the house down further, reducing the number of retrofits needed as part of the offset and therefore the cost. Section 3.2 demonstrated that these systems can be cost beneficial in their own right. If water was reused for toilets and outdoor use it could save a quarter of total household use.			
3 – Water Offsetting	Annual residual water needing to be saved per water neutral property	92,345 litres	69,679 litres	Annual demand minus annual water saving

[78] Butterworth, Baker and Hoskin (2019) CIEEM Case Studies - Aylesbury https://cieem.net/wp-content/uploads/2019/02/C776b-Case-studies.pdf
[79] EST (2019) Independent Review of Water Labelling in the UK https://www.waterwise.org.uk/wp-content/uploads/2019/02/Water-Labelling-Summary-Report-Final.pdf
[80] A PCC of 'approximately 82' is used because this is what the available data allows from sources referenced throughout this paper.

	Annual assumed water saving per retrofitted property	12,775 litres	12,775 litres	Based on 35 litre per property per day savings from Thames and Southern retrofit programmes x 365 days
	Approximate number of homes needed to be retrofit to offset	7	5	Offset needed divided by calculated saving per retrofit
	Estimated householder saving on energy and water bills for each retrofitted property over 5 years[81]	£73	£73	Based on 35 l per property / 2.3 occupancy = 15 lppd reduction and then halving the bill savings from the approx. 30 lppd reduction in the 110 water labelling option in the Phase 2 labelling report....so £29 divided by 2
	Cost per property retrofitted	£48 - £100	£48 - £100	Figures provided by Southern Water and Thames Water
	Total cost of offsetting (per new home built)	£336 - £700	£240 - £500	Cost per property x rounded number of retrofitted properties
	Total savings on water and energy bills over five years for the retrofit homes	£508	£365	Five year saving x rounded number of retrofit properties
In the case of a new house built to 110lppd the total cost of water neutrality is £9 for the house (Section 3.5 and Appendix B (DCLG 2014)) plus £336 to £700 for the 7 houses retrofit. The savings over 5 years on bills are £145 for the house and £508 for the 7 retrofit houses. Therefore, after around 5 years the savings from water neutrality are greater than the costs of doing it.				

[81] Five year saving on energy and water bill per year per property retrofitted (based on 35 l per property / 2.3 occupancy = 15 lppd reduction and then comparing 15 lppd reduction with 30 lppd reduction in 110 labelling option)

8. Conclusions and Recommendations

This report has shown that water neutrality has the potential to deliver large scale water and carbon savings, subject to overcoming barriers, mostly in its practical delivery.

The savings achieved through water neutral developments could help ensure that we have sufficient water available to meet the existing needs of people, business and the environment in a changing climate. Crucially, water neutrality can also free up the water that will enable future housing and business growth and enhance the environment. Committing to deliver a water neutral development would strengthen the case for development, particularly in areas where water availability is constrained (now or in the future).

Water neutrality can be delivered with existing technology and water saving approaches and there are examples of where it is being adopted regionally; for new housing developments; by businesses and by industrial sectors. However, to date the uptake of water neutrality for new housing development in the UK has been limited and public awareness of water resource issues aren't creating enough demand for such projects to date.

Greater policy support for water neutrality is needed at a national and local level. For example:

- The National Planning Policy Framework should require the consideration of water neutrality in areas with constrained water resources in a similar way to the requirement for flood risk "neutrality".
- Local planning policies should require developers to work with the local water company on proposals to minimise the water demand impact for new developments over a threshold size.

In advance of seeing supportive policy change there should still be engagement between developers, water companies, and local authorities at a very early planning stage to discuss water resources and the potential for exemplary water neutral housing developments. For example, the OxCam Arc development could provide a fantastic opportunity to showcase water neutrality at scale in a severely water stressed part of the UK.