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Water Labelling Options: Cost Benefits Analysis for Northern Ireland

Northern Ireland Water

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1. Background

There is ever growing pressure on governments, water companies, manufacturers and wider society to reduce demand on water resources. As the impacts of climate change and population growth are realised by way of drought and flooding events across the UK, the need to act has never been more urgent. The framework for action exists. The UK Government has outlined plans to align with industry to define ambitious consumption targets as part of their 25 year environmental plan "A Green Future".

Energy Saving Trust were previously commissioned by Waterwise, Defra and the water companies' Collaborative Fund to carry out a cost benefit analysis into options for improved water efficiency labelling of domestic fittings and appliances in the UK. That work considered a number of options for water labelling, including voluntary and mandatory schemes, led by government or industry, supported by marketing campaigns, and linked to minimum standards for fittings and appliances in new-build properties and in general refurbishment. The analysis included efficiency improvements for kitchen and bathroom taps, showers, baths, toilets, washing machines, dishwashers and external water products, in new and existing domestic properties.

The study concluded that the most cost-effective option would be to introduce a mandatory, government led water label, and to link it to standards in building regulations, and to new minimum performance standards for the sale of fittings and appliances. This option saved the most water of all the options modelled but also showed the most favourable cost benefit ratio. The study also concluded that new UK-wide labelling regulations, incorporating increasingly tighter minimum standards for sale of products, could be complemented by changes to the building regulations in each nation of the UK, with each government choosing the rate at which different label ratings are set as minimum requirements for new-build properties and major refurbishments.

The cost benefit analysis was carried out for a UK-wide initiative, based on data sets and assumptions applicable to the UK as a whole. Northern Ireland Water have now commissioned this follow-on work to re-run the calculations using Northern Ireland-specific data where available, and so to give an indication of the costs and benefits from a Northern Irish perspective. Northern Ireland-specific data sets have included:

- Zero properties charged on the basis of metered supply
- Northern Ireland fuel mix for water heating

- Northern Ireland new build projections
- Northern Ireland population projections
- Northern Ireland Water's marginal cost for supplying water
- Northern Ireland Water's embodied carbon factors for water supply and wastewater treatment

Where no Northern Ireland-specific data is available, UK data has been applied on a pro-rata basis.

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2. Methodology overview

The cost benefit analysis was carried out as follows:

- Existing and potential water consumption figures for each product type were calculated
- Uptake rates for fittings and appliances were calculated from sales and new-build projections
- Intervention schedules were developed for each scenario, to define dates at which increased standards would be applied
- Costs were estimated for introducing and administering the scheme, and for additional costs in the manufacture and supply of compliant products
- Each scenario was modelled over a 25 year time span, and compared with a business as usual case, to calculate water saved, heating energy saved, reduction in cost of supplying water, carbon dioxide saved through reduced water supply, reduced wastewater treatment and reduced water heating requirement
- The financial savings were combined, and compared to the combined costs for government, industry and householders, to give a cost benefit ratio for each scenario

Input to the modelling came from a wide variety of sources, including published research, Energy Saving Trust research, industry inputs, existing regulations, results from international water labelling and regulatory schemes, and proxy figures from similar interventions not directly related to water efficiency labelling. Further details on the methodology, including the range of data sources used, can be found in the Appendix.

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3. Results

Four scenarios have been modelled. In the original study these were named according to their equivalent for new builds in the English building regulations. In Northern Ireland there are no water regulations for domestic properties, so the scenarios using the English building regulations litres per day rankings were used as a means to differentiate between different water usage patterns. These scenarios have been re-named as follows to provide them with a meaningful context in relation to Northern Ireland:

- **Tightest new build standards in UK currently** – as currently applied to new build properties in Wales and some parts of England, but applied here to all new purchases and installations. Equivalent to 110 litres per person per day in the English building regulations water efficiency calculation methodology.
- **10% better than current best standards** – approximately 10% tighter standard than the above. Equivalent to 100 litres per person per day in the English building regulations water efficiency calculation methodology.
- **Best commercially available domestic technology** – requiring all purchases and installations to use the best technology currently commercially available in the UK domestic market. Equivalent to 95 litres per person per day in the English building regulations water efficiency calculation methodology.
- **Best commercially available technology** – requiring all purchases and installations to use the best technology currently commercially available in the UK, whether for the domestic or non-domestic market. Equivalent to 85 litres per person per day in the English building regulations water efficiency calculation methodology.

The key results for these four scenarios, modelled over 25 years, are presented in Table 1, and the expected payback period for buyers of new homes (the period taken for reduced water heating bills to repay any increase in home purchase cost) are presented in Table 2.

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Cost/Benefit		Type	Units	Tightest new build standards in UK currently	10% better than current best standards	Best commercially available domestic technology	Best commercially available technology
		English Building Regulations LPD Equivalent =		110	100	95	85
Costs	Sector	Government	£ Million	£0.3	£0.3	£0.3	£0.3
		Manufacturers	£ Million	£3.5	£3.5	£3.5	£3.5
		Households	£ Million	£12.6	£13.4	£13.9	£16.0
	Total	Total Absolute Cost	£ Million	£12.6	£13.4	£13.9	£16.0
		Average Cost per Household	£ per household	£16.9	£18.0	£18.8	£21.5
		Average Cost per Household	£ per household per year	£0.68	£0.72	£0.75	£0.86
Benefits for Households	Water	Total Cumulative Water Saved	Million Litres (Ml)	227,294	260,673	274,009	296,094
		Water savings in year 25:	Million Litres per day (Ml/day)	24.91	28.57	30.03	32.45
			Litres per capita per day	22.62	26.32	27.65	30.61
			Litres per household per day	56.2	65.4	68.7	76.0
	Energy	Hot Water Energy Savings	MWh	6,014	7,430	7,947	8,683
	Financial	Energy Bill Savings	£ Million	£200	£275	£297	£346
		Average Saving per Household	£ per household	£269	£370	£399	£465
		Average Saving per Household	£ per household per year	£11	£15	£16	£19
		Total net saving per Households	£ per household total	£252	£352	£380	£443
		New Build Energy Bill Savings	£ Million	£110	£154	£166	£179
Benefits for Water Suppliers	Financial	Marginal Cost Savings	£ Million	£24.9	£28.6	£30.0	£32.4
Benefits to CO2 Reduction		Energy Emissions Savings	MtCO2e	1.66	2.05	2.19	2.39
		Water Supply Emissions Savings	MtCO2e	0.03	0.03	0.03	0.03
		Wastewater Emissions Savings	MtCO2e	0.06	0.07	0.07	0.07
		Total Emission Savings	MtCO2e	1.74	2.15	2.29	2.50
Cost:Benefit Ratio		Combined	Ratio	1:18	1:23	1:23	1:24

Table 1: Savings achieved over 25 years

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Scenario	Cost Benefit	Unit	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Tightest new build standards in UK currently	Additional costs	£ Million	£1.25	£0.74	£0.60	£0.28	£0.05	£0.04	£0.04	£0.04	£0.04	£0.04	£0.04	£0.03	£0.03	£0.03	£0.03	£0.03	£0.02	£0.02	£0.02	£0.02	£0.02	£0.02	£0.01	£0.01	£0.01
	Bill savings	£ Million	£0.56	£0.51	£0.55	£0.52	£0.52	£0.53	£0.53	£0.53	£0.55	£0.55	£0.54	£0.55	£0.55	£0.55	£0.54	£0.54	£0.54	£0.53	£0.53	£0.53	£0.52	£0.52	£0.51	£0.51	£0.51
	Payback	Weeks	115.5	95.8	82.5	69.4	56.6	48.0	41.7	37.0	33.2	30.2	27.8	25.7	23.9	22.4	21.1	19.9	18.9	18.0	17.1	16.4	15.7	15.1	14.5	14.0	13.5
10% better than current best standards	Additional costs	£ Million	£1.25	£0.74	£0.60	£0.37	£0.11	£0.09	£0.06	£0.04	£0.04	£0.04	£0.04	£0.03	£0.03	£0.03	£0.03	£0.03	£0.02	£0.02	£0.02	£0.02	£0.02	£0.02	£0.01	£0.01	£0.01
	Bill savings	£ Million	£0.58	£0.56	£0.63	£0.75	£0.76	£0.76	£0.77	£0.78	£0.79	£0.79	£0.78	£0.79	£0.79	£0.78	£0.78	£0.77	£0.77	£0.76	£0.75	£0.75	£0.74	£0.74	£0.73	£0.73	£0.72
	Payback	Weeks	110.8	89.8	75.4	60.6	48.4	40.4	34.6	30.2	26.8	24.1	22.0	20.2	18.7	17.5	16.4	15.4	14.6	13.9	13.2	12.6	12.1	11.6	11.1	10.7	10.3
Best commercially available domestic technology	Additional costs	£ Million	£1.36	£0.80	£0.65	£0.35	£0.09	£0.07	£0.06	£0.04	£0.04	£0.04	£0.04	£0.03	£0.03	£0.03	£0.03	£0.03	£0.02	£0.02	£0.02	£0.02	£0.02	£0.02	£0.01	£0.01	£0.01
	Bill savings	£ Million	£0.60	£0.59	£0.67	£0.87	£0.88	£0.88	£0.89	£0.89	£0.91	£0.91	£0.90	£0.90	£0.90	£0.89	£0.89	£0.88	£0.87	£0.87	£0.86	£0.85	£0.85	£0.84	£0.83	£0.83	£0.82
	Payback	Weeks	118.8	95.2	79.0	60.6	47.1	38.6	32.8	28.5	25.1	22.6	20.5	18.8	17.4	16.2	15.2	14.3	13.5	12.8	12.2	11.6	11.1	10.7	10.2	9.9	9.5
Best commercially available technology	Additional costs	£ Million	£1.36	£0.80	£0.65	£0.35	£0.09	£0.07	£0.29	£0.20	£0.15	£0.09	£0.04	£0.03	£0.03	£0.03	£0.03	£0.03	£0.02	£0.02	£0.02	£0.02	£0.02	£0.02	£0.01	£0.01	£0.01
	Bill savings	£ Million	£0.60	£0.59	£0.67	£0.87	£0.88	£0.88	£1.14	£1.12	£1.11	£1.00	£0.99	£0.99	£0.99	£0.98	£0.97	£0.96	£0.96	£0.95	£0.94	£0.93	£0.92	£0.91	£0.91	£0.90	£0.89
	Payback	Weeks	118.8	95.2	79.0	60.6	47.1	38.6	33.5	29.5	26.3	23.8	21.6	19.8	18.3	17.0	15.9	15.0	14.2	13.4	12.8	12.2	11.6	11.2	10.7	10.3	9.9

Table 2: Payback for new build home buyers

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4. Discussion

Unsurprisingly, the most ambitious option saves the most water, reducing per capita consumption by **32 litres per person per day** after 25 years.

This option is also the most cost effective, with a **cost:benefit ratio of 1:24**. The more cautious options deliver lower water savings, as expected, but also with slightly lower cost:benefit ratios.

The carbon dioxide equivalent savings, which include the embodied carbon dioxide of water, come to **2.5 million tonnes after 25 years**, which is the same amount absorbed by a forest the size of Armagh and Down combined[1].

These figures mirror the UK results in general, but with higher per capita savings and lower cost:benefit ratios. The higher savings reflect the current situation that Northern Ireland does not have domestic water building regulations, meaning moving to an ambitious new standard in Northern Ireland will save more in comparison to England as the baseline projection is for higher consumption. The lower cost:benefit ratio reflects the lack of water metering for billing in Northern Ireland. Financial savings for householders are therefore significantly lower despite the higher expected water savings.

In terms of impact on buyers of new build properties, the new standards are expected to add to the cost of a new home, but the savings from reduced water heating are expected to repay the additional cost in **around 2 years** across all scenarios at the outset. Over the 25 year period modelled, the payback is expected to reduce gradually to **around 10 weeks** for the more ambitious scenarios.

[1] Assumes 4,600 square kilometres of forest, absorbing 540,000 kgCO2/year/km2, from https://www.forestry.gov.uk/pdf/6_planting_more_trees.pdf/$FILE/6_planting_more_trees.pdf

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5. Appendix

Scenarios

In total, four new scenarios were modelled against the baseline. Each scenario is a variation on the original preferred scenario from the first study, with different levels of ambition for requiring efficient water fittings and appliances (including showers, baths, taps, toilets, external water using products, washing machines and dishwashers). The primary purpose of the modelling was to evaluate the effect of applying these restrictions through building regulations and to the wider market, to underpin a mandatory government water-labelling scheme.

The scenarios were originally described in terms of the litres per day (LPD) metric used in the English Buildings Regulations Part G water efficiency calculator for new homes. These scenarios were then defined in terms of maximum consumption rates for each product category covered.

5.1 Detailed Scenario Modelling Methodology

Calculations

The cost benefit analysis was structured quite simply; the uptake rates relate to the number of water efficient products compliant year on year with the total number of new build sales and current stock being the maximum potential for compliance for a given water standard scenario. The uptake rates are broken down into the seven product categories and by the eight scenarios. The uptake rates are calculated from numerous sources and peer reviewed to ensure they are as representative of the scenarios as possible and are as up to date as they can be. The uptake rates are the primary driver of both the costs and the benefits, and in the majority of instances, the scale of the uptake proportionately affects the scale of the costs and benefits.

The costs were sourced from numerous places including existing international water labelling schemes, UK and Northern Ireland Government and industry schemes that were relevant for a particular scenario. Northern Ireland statistics were used to adjust and proportion the costs so they are representative of a given scenario, geographic scale and future financial changes according to a projected timescale of 25 years.

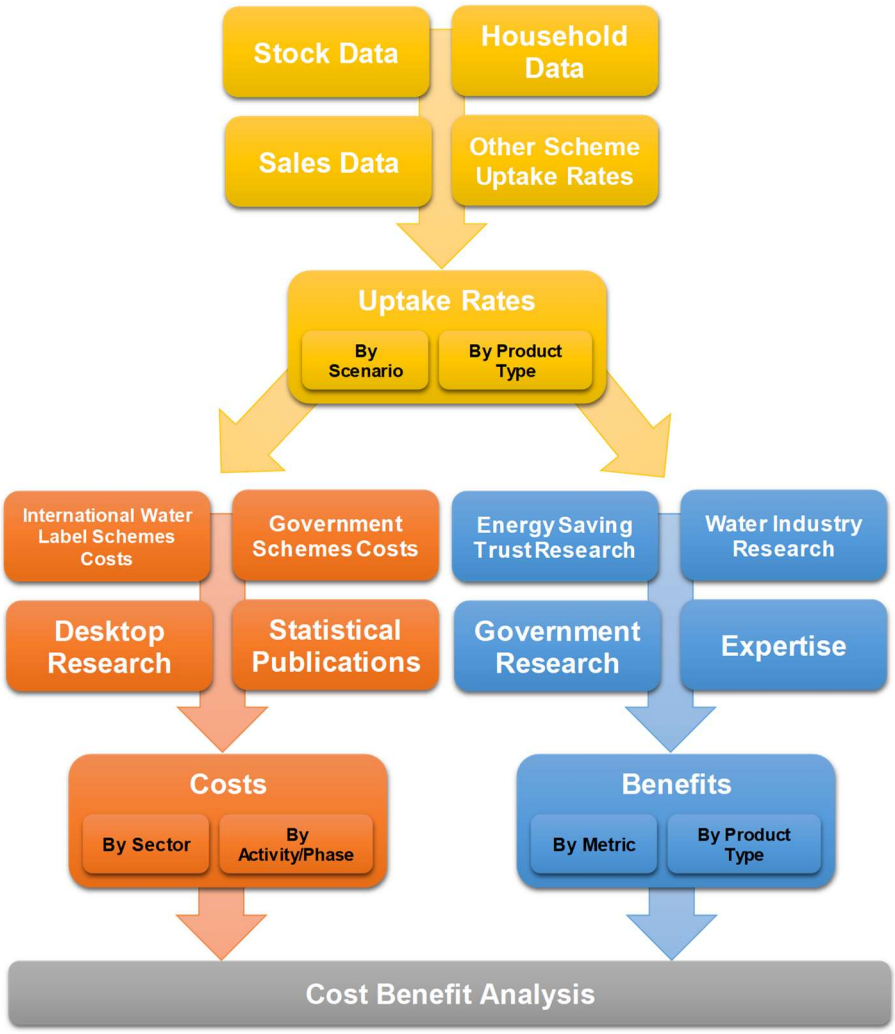

Figure 1: Workflow of detailed scenario modelling

The benefits were calculated using a combination of Energy Saving Trust, water industry and government research. A weighted average saving for each product category was calculated using average flow rates and projected flow rates of water efficient technologies. These per product savings were multiplied by the uptake rates for each scenario resulting in the water savings over time, which were then used to calculate all the subsequent results.

Fittings assumptions

The cost benefit analysis (CBA) model requires assumptions to be made for each product type on the amount of water consumed. The England Building Regulations Part G provides these assumptions 110 LPD or "Tightest new build standards in UK currently". These assumptions represented the top two highest water consuming scenarios.

Scenario	Tightest new build standards in UK currently	10% better than current best standards	Best commercially available domestic technology	Best commercially available technology
LPD	**110**	**100**	**95**	**85**
Toilet Large Flush **(l/use)**	4.00			
Toilet Small Flush **(l/use)**	2.60			
Toilet Average **(l/use)**	3.06	2.91	2.83	2.20
Shower **(l/min)**	8.00	7.41	7.11	6.50
Bath **(litres capacity)**	170.00	158.40	152.60	152.60
Basin Taps **(l/min)**	5.00	4.51	4.27	1.50
Sink Taps **(l/min)**	6.00	4.85	4.27	4.27
Dishwasher **(l/place setting)**	1.25	0.93	0.78	0.50
Washing Machine **(l/kg)**	8.17	8.17	8.17	6.70

Table 3: Assumed water consumption by product type based on the England Building Regulations Part G Water Efficiency Calculator

To find the lowest possible water-consuming scenario the Australian Water Efficiency Labelling Scheme (WELS) database was analysed. For each product type the minimum water consumption values were extracted from the database. These values represented the lowest water consumption possible with current technology giving us our extreme scenario. Once entered into the English Building Regulations Part G water efficiency calculator these assumptions equated to 84.2 LPD or 85 LPD rounded, known as the "Best commercially available technology" scenario.

Uptake

Uptake rates describe the number of water products that are compliant year on year, with the maximum potential determined by the total number of sales. The uptake rates are broken down into the seven product categories and by the two uptake scenarios.

The uptake rates were calculated as a percentage of water efficient products installed; this percentage was then applied to the total sales of all the product category sales for a given year. This sales data was based on DEFRA's Market Transformation Programme[2] projections for showers, baths, taps, washing machines and dishwashers. This data was interpolated and extrapolated to fill in the missing years and projected to the timescales of this analysis for a 25-year time horizon.

[2] http://efficient-products.ghkint.eu/

This data stopped being updated in 2011 when the government programme funding ceased; although relatively old, the basis of the projections is still reliable. However, it should be noted that only a new stock model study using current sales and up to date policy interventions would be more representative; all currently available sales data only analyses historic sales and does not project the market.

Toilet sale projections were calculated using the projected ownership rates, projected households from DEFRA's Market Transformation Programme and the assumed lifetime of the average toilet of 15 years. Year on year growth in sales was assumed for the first 15 years, thereafter the year 1 sales volume difference was added to year 16 to account for toilet purchased in year 1 needing to be replaced. There was a lack of projected sales data for toilets therefore this was the only suitable alternative.

As with toilet sales data, no external use product (i.e. garden water using products and high-pressure washers) data was available. A market study from WRAP[3] stated the number of units sold in 2013 and an increase in sales by 7% from the previous year; therefore, sales were calculated for 2014 using the 7% increase. This difference of 556,075 units was assumed to be the annual sales year on year in the absence of other sources. This is the least reliable source of data for sales.

There were two main uptake scenarios:

Uptake Scenario 1 Installations covered by building regulations for new builds homes and major domestic renovations

For this scenario the building regulations are assumed to cover all installations occurring in new build homes and major retrofit projects that are required to go through a local authority. The derived uptake rates assume that every new build home in Northern Ireland would install one of each product type except for taps where two sets were assumed to be installed.

In addition to this, it is assumed that 34% of the sales not attributed to new build homes were for major domestic refurbishments. This proportion was calculated from MTW Research where the total UK repair, maintenance and improvement market value was proportioned against the total construction market value. This proportion was used as a suitable proxy as data pertaining to the number of water product sales for domestic retrofits each year could not be sourced. This resulted in 48% of the total sales for these products attributed to this uptake scenario. This figure is effectively an estimate of all significant professional installations, and so should be considered a proxy upper limit for installations covered by Building Regulations. Actual implementation of Building Regulation requirements for retrofit schemes would achieve an unknown proportion of this depending on scope of the requirements and effectiveness of implementation.

[3] *WRAP Water Using Products: Domestic garden products market research, flow rate and performance testing*

Uptake Scenario 2 Installations by householders buying products from stores directly or by service professionals as a small-scale job

It was assumed that the remaining total sales per year after excluding the sales attributed to Uptake Scenario 1, was for householders buying products from stores directly, to be installed by themselves or by service professionals as a small-scale job. This resulted in 52% of the total sales for these products attributed to this uptake scenario.

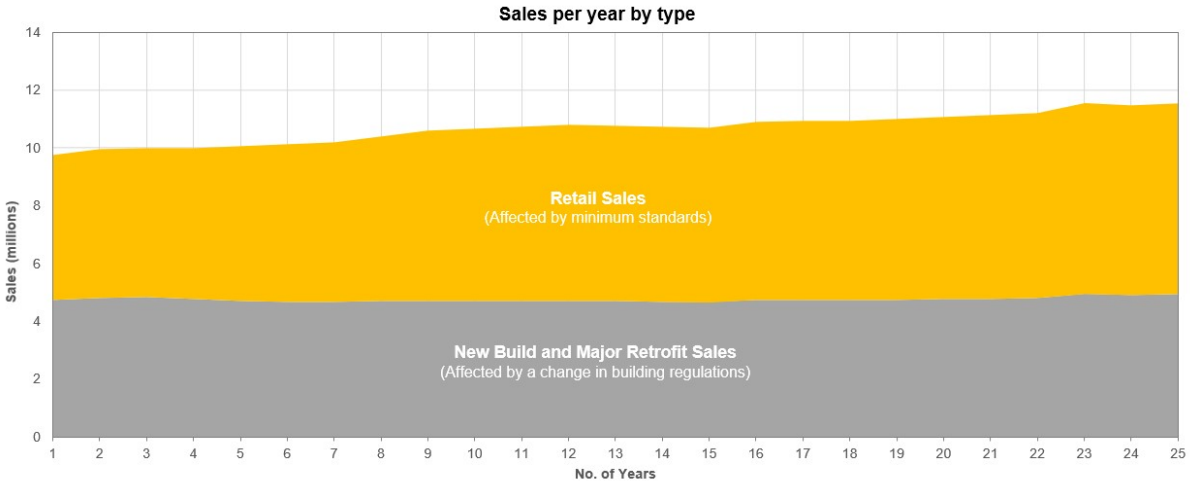

Figure 2: Sales per year by type of sales.

The figure above shows the assumed split between these two streams of sales and represent the proportion split of the sales effected if only one stream had water efficiency requirements place upon it. It shows that 56% of sales are assumed to be from retail sales and 44% are from new builds and major retrofits.

Behaviours

There are assumptions in the modelling which assume that the durations people use water using devices changes over 25 years e.g. people taking less baths and more showers. These assumptions were taken from DEFRA's Market Transformation Programme[4]. These represent the natural shift of water using behaviour (people's lifestyles favouring less baths and more showers) rather than a concerted effort from a campaign or incentive scheme to use water less overall.

The modelling does not assume that any incentivised behaviour change occurs from using products less or more efficiently (through government or water company schemes for example). The primary driver for water reduction in this modelling comes from the devices themselves using less water during use.

No adjustments were made for any rebound effect, whereby householders use fittings and appliances more often or for longer due to awareness of the increased water efficiency. What little evidence there is suggests that behaviour changes of this nature only occur for water

[4] http://efficient-products.ghkint.eu/

fittings if there is a perceived reduction in performance – for example, a less effective shower head taking longer to rinse off soap. This study was based on the premise that standards in any new water labelling scheme would maintain product performance while reducing water usage, and so no rebound effects were included.

Costs

The costs were broken down by phase, aspect and ownership; with the phase relating to the initial setup of the water label, the administration of it and the practical manufacturing phase of implementing the water label in practice. The aspects include marketing, maintaining a database, staffing enforcement etc. Some of the costs are static figures associated with a particular year and others are dynamic, depending on the amount of uptake different scenarios experience. This section will look at each aspect in turn and detail the differences between the different scenarios.

Standards/Policy Development

This is a static cost only applied to year 1 of all the scenarios. It represents the initial work needed to develop the technical standards for the water label, establish the scales of the ratings for each product category, conduct a market review of the product categories, all associated external consultancy fees, research fees and research costs. This was sourced from the Australian Water Efficiency Labelling and Standards Scheme (WELS)[5] where they detailed their estimated costs for 2008-09 for the development of technical standards of $85,000. This figure was then uplifted to account for UK inflation rates up to 2018 and converted into pounds sterling using a conversion rate of $0.57 to the pound. This resulted in a UK cost of £59,908 of which £1,782 is assumed Northern Ireland's share.

Research Advisory Group Costs

It is assumed that there would be four instances of this cost occurring in the first year. This cost represents a group of stakeholders and experts coming together to advise, contribute and help develop the standards as they progress in the first year. This was sourced from the Australian Water Efficiency Labelling and Standards Scheme (WELS)[6] where they detailed their estimated costs for 2013-14 for the WELS advisory group support of $9,000 for each instant. This figure was then uplifted to account for UK inflation rates up to 2018 and converted into pound sterling using a conversion rate of $0.57 to the pound. This resulted in a UK cost of £5,487 per instance and a total first year cost of £21,946, of which £653 is assumed to be Northern Ireland's share.

Marketing

This is a static cost applicable to every year for all scenarios. This cost represents ongoing promotion of the scheme to help build awareness of the label which in turn will help drive the uptake in water efficient products. This was sourced from firstly the Australian Water Efficiency

[5] http://www.waterrating.gov.au/
[6] http://www.waterrating.gov.au/

Labelling and Standards Scheme (WELS)[7] where they detailed their estimated costs for 2008-09 for ongoing promotion of the scheme at a cost of $70,000 or £49,336 when uplifted to account for inflation up to 2018 and converted into British pounds using a conversion rate of $0.57 to the pound. Secondly, the website budget for the Energy Saving Trust's Energy Saving Recommended (ESR) scheme which was run on behalf of UK government in 2006/07 was used in combination with the above, which was of £6,500. Combined the assumed marketing budget year on year for the scenarios was assumed to be £55,836 a year, of which £1,719 is assumed to be Northern Ireland's share.

Enforcement

This is a dynamic cost applicable to every year for all scenarios. This was sourced from the National Measurement Office monthly spend from April 2014 until March 2016[8]; this government body regulates and enforces several schemes for multiple government departments. As this government body regulates several schemes not only related to energy labelling scheme the costs had to be factored down so they were more representative; so it was assumed that as the Department of Energy and Climate Change (DECC) provided 44% of the funding to this body and there were 3 schemes the body regulated that belonged to DECC. Taking this into account the costs were factored down by 44% and then a third to get a representative cost. Those costs were then averaged into the spending categories that were listed in the data that related to enforcement: auditing, creating enforcement marketing material and legal fees.

It was assumed that for government led schemes that both enforcement marketing material and legal fees would be applicable as fixed year on year UK cost of £11,474; as it was recognised that government would need to show due diligence, follow through on enforcement and be transparent which would incur more cost.

It was assumed for the variable cost that the maximum cost incurred for the mandatory schemes would be £96,147 which is a combination of the average yearly auditing and product testing costs. This represents the need for a mandatory scheme to do risk-based product testing and internal audits of documentation. This was proportion according to the uptake rates where the maximum cost would represent 100% of the years for a given year. All these costs were adjusted for inflation up to 2018. Northern Ireland's share at year 1 would be £1,053 reducing to £776 In year 25.

	Mandatory Gov
Fixed Cost	£11,474
Vairable Cost (@100%)	£96,147

[7] http://www.waterrating.gov.au/

[8] https://www.gov.uk/government/publications?keywords=spend+2015&publication_filter_option=all&topics%5B%5D=all&departments%5B%5D=national-measurement-and-regulation-office&official_document_status=all&world_locations%5B%5D=all&from_date=&to_date

Database

This is a static cost applied to all years of all scenarios. This cost represents the creation, maintenance and growth of a database containing all the registered products, enforcement and performance information to help administer the scheme. This was sourced from the Australian Water Efficiency Labelling and Standards Scheme (WELS)[9] where they detailed their estimated costs for 2008-09 for the database, website portal and administration of the database at a cost of $95,000. This figure was then uplifted to account for UK inflation rates up to 2018 and converted into pound sterling using a conversion rate of $0.57 to the pound. This resulted in an annual UK cost of £66,956, of which £2,061 is assumed to be Northern Ireland's share.

Staffing Costs

This is a static cost applicable to every year for all scenarios, but each scenario staffing requirements were built on assumptions. Average salaries were sourced from the GOV.UK website detailing the salary for the Deputy Director for Green Deal and Office of National Statistics (ONS)[10]. Weighted average salaried were calculated for staff involved in head offices/management consultancy activities of £31,855 per annum, for office administration for £16,366 per annum, for professional/scientific/technical activities for £32,270 per annum and the Deputy Director for Green Deal salary was used to represent an assumed cost of a director involvement at £62,500 per annum. Northern Ireland's share is £12,384 per year.

Full Time Equivalent Staff

Director	Management Consultants	Office Support/ Administration	Professional/ Scientific/ Technical	Total
0.5	3.0	5.0	6.0	14.5

It should be noted that staffing structures and resourcing was researched to use a proxy, however only high level management was ever published publicly, therefore in the absence of such data assumptions based on experience from Energy Saving Trust staff was used as they have previously administered similar schemes.

Registration Fees

Registration fees relates to the cost manufacturers need to pay to register their products as part of a mandatory government led water labelling scheme. For the purposes of this modelling we have assumed that all the ongoing administrative costs incurred by government (marketing, enforcement, database and staff) would be funded by government but would be fully recouped from manufacturers via registration fees. For example, in year 1 it is estimated that £17,217 was incurred by Northern Ireland government in operational costs; therefore this is the total cost to manufactures in registration fees. The only cost not recouped by government is the setup costs.

[9] http://www.waterrating.gov.au/

[10] https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/datasets/agegroupbyindustry2digitsicashetable21

This is similar to the Australian WELS model where they recoup 80% of the costs of the scheme in this way.

Testing Products

This is a dynamic cost applicable to every year for all scenarios. This was sourced from the National Measurement Office monthly spend from April 2014 till March 2016[11]; this government body regulates and enforces several schemes for multiple government departments. As this government body regulates several schemes, not only related to energy labelling scheme, the costs had to be factored down so they were more representative; it was assumed that as the Department of Energy and Climate Change (DECC) provided 44% of the funding to this body and there were 3 schemes the body regulated that belonged to DECC the costs were factored down by 44% and then a third to get a representative cost. The factored down cost was then filtered according to activity and product testing was isolated and averaged to give a value of £977 per product testing.

It was assumed that 1,843 products would need to be tested for the water label under a mandatory scenario in the first year; this is based on the number of unique products sold by the retailers to consumers, based on desktop research. Thereafter it is assumed that an additional 10% of the initial number will need testing each year. This is an assumption and represents the introduction of new products each year.

It was difficult to source a total number of unique products in the market to estimate the total cost of product testing. Commercial companies do not give out this information publicly as it is deemed commercially sensitive.

Labelling Costs

This is a dynamic cost applicable to every year for all scenarios. This cost represents a conservative cost to produce and print a water label including the labour. This was sourced from the Australian Water Efficiency Labelling and Standards Scheme (WELS)[12] where they detailed their conservative estimate for labelling costs in 2008 at $1 per label, using a conversion rate of $0.57 to pound sterling that equates to around 57p per label. It should be noted that the labelling estimates ranged from Australian 10 cents to $1. A UK study looking at costs for changing the food labelling system identified wide variation depending on the materials used, the printing techniques chosen, complexity of the label design and the economies of scale a particular company can manage. It was decided to go with a conservative high cost from the WELS study as, unlike food labelling, the water label will have less content that needs to be changed between product types. Also, the WELS data is from an existing mandatory water labelling scheme. The

11 https://www.gov.uk/government/publications?keywords=spend+2015&publication_filter_option=all&topics%5B%5D=all&departments%5B%5D=national-measurement-and-regulation-office&official_document_status=all&world_locations%5B%5D=all&from_date=&to_date=

12 http://www.waterrating.gov.au/SiteCollectionDocuments/cost-effectiveness-wels.pdf

WELS estimates do cover a wide range but, in the absence of any evidence for an average figure, it was considered prudent to be conservative and adopt the upper end of the range.

This labelling costs data was then scaled up according to the total number of additional sales of water efficient products introduced in a given year.

Research and Development

This is a dynamic cost applicable to every year for all scenarios. This was calculated from statistics from the Office of National Statistics (ONS)[13] detailing the total expenditure of business enterprise research and development (R&D). Firstly, the retail sector R&D expenditure was taken of which we found that 2.84% of that related to hardware. Secondly the total value of the hardware market for 2016 and 2017 was found from ONS. The R&D expenditure was divided by the total hardware market value to calculate the percentage of the market value spent on R&D, which equated to 0.08%.

Using Statistic.com[14], WRAP study[15] and MTW Research[16] the sales value for each of the product categories was calculated, and the total value was then proportioned down to 0.08% and factor up to account for inflation up till 2018. The final value of £325,830 is assumed to represent 100% of the R&D expenditure for all the product categories for this study. This value was applied according to the proportion of uptake per year in relation to the total number of sales for that year (e.g. if the total sales for showers was 10,000 units and a scenario showed only 10% of those sales were of water efficient products it was assumed that only 10% of the R&D budget was applicable).

It should be noted that this is an estimate based on numerous assumptions to try and represent these specific markets. Actual data from manufacturers could not be sourced, as this data is commercially sensitive, and it is very unlikely this would be released to externals. It was important however that an estimated cost for this aspect was represented in the analysis to acknowledge that this would be a source of cost for the manufacturers.

Consumer Cost

This cost relates to water efficient products being more expensive at point of sale, increasing the cost burden to consumers. Desk research carried out as part of this study identified the current price differential between the market average and those products that would comply with the 95LPD standard ("Best commercially available domestic technology" scenario). This differential was applied pro rata to the 110 ("Tightest new build standards in UK currently" scenario) and 100LPD ("10% better than current best standards") scenarios (86% and 95% of the full price premium). The differential was extrapolated for the 85LPD ("Best commercially available

13 https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/datasets/ukbusinessenterpriseresearchanddevelopment

14 https://www.statista.com/statistics/327205/plastic-bath-and-shower-sales-value-uk/

15 *WRAP Water Using Products: Domestic garden products market research, flow rate and performance testing*

16 http://www.marketresearchreports.co.uk/

technology") scenario (112%) and then doubled (124%) to account for the fact that this scenario would require the use of some products not currently commercially available for the domestic sector.

	Year 1	Year 4	Year 7	Total
110 LPD	86%			86%
100 LPD	86%	9%		95%
95 LPD	95%	5%		100%
85 LPD	95%	5%	24%	124%

The cost premium of buying water efficient products was staggered in the same years the minimum standards come into force. For example, for the 100 LPD scenario the first year experiences 86% of the premium and then in year 4 an additional 9% is added, making the total premium experienced to 95%. For the 85 LPD scenario, initially in year 1, 95% of the premium is experienced, then an additional 5% taking the total to 100%; and finally an additional 24% to year 7 taking the total to 124%.

These premium costs are reduced down equally over the subsequent 4 years to zero; where it is assumed market forces have brought the price of the water efficient products to the level the non-water efficient products were at before the start of the scheme.

Benefits

The benefits were calculated using a combination of Energy Saving Trust, water industry and government research. A weighted average saving for each product category was calculated using average flow rates and projected flow rates of water efficient technologies; the figures used in each scenario are shown in Table 4 below. These per product savings were multiplied by the uptake rates for each scenario, resulting in the water savings over time; these water savings are the basis for the majority of the other saving results such as the energy savings and emission savings. This section will detail the methodology, assumptions and factors used to calculate the benefits.

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			Tightest new build standards in UK currently (110 LPD)		10% better than current best standards (100 LPD)		Best commercially available domestic technology (95 LPD)		Best commercially available technology (85 LPD)	
Vairable	Product	Units	Year 1	Year 25	Year 1	Year 25	Year 1	Year 25	Year 1	Year 25
Ownership	Taps (Washbasin)	Pairs per HH	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
Ownership	Taps (Kitchen)	Pairs per HH	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
Ownership	Taps (Washbasin)	%	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Ownership	Taps (Kitchen)	%	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Baseline	Taps (Washbasin)	Litres per use	7.76	7.76	7.76	7.76	7.76	7.76	7.76	3.93
Baseline	Taps (Kitchen)	Litres per use	9.14	9.14	9.14	9.14	9.14	9.14	9.14	5.24
Baseline	Taps (Washbasin)	per person/day	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Baseline	Taps (Kitchen)	per person/day	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
Water Efficient Alternative	Taps (Washbasin)	Litres per use	3.28	1.98	3.28	1.90	3.28	1.80	3.28	0.98
Water Efficient Alternative	Taps (Kitchen)	Litres per use	3.93	3.64	3.93	2.96	3.93	2.80	3.93	2.80
Water Efficient Alternative	Taps (Washbasin)	per person/day	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Water Efficient Alternative	Taps (Kitchen)	per person/day	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
Ownership	Toilets	Per Household	1.44	1.46	1.44	1.46	1.44	1.46	1.44	1.46
Baseline	Toilets	Litres per use	5.83	5.77	5.83	5.77	5.83	5.77	5.83	4.64
Baseline	Toilets	per person/day	4.71	4.71	4.71	4.71	4.71	4.71	4.71	4.71
Water Efficient Alternative	Toilets	Litres per use	3.06	2.70	3.06	2.60	3.06	2.53	3.06	2.20
Water Efficient Alternative	Toilets	per person/day	4.71	4.71	4.71	4.71	4.71	4.71	4.71	4.71
Baseline	Showers (Average)	Litres per use	57.13	57.13	57.13	57.13	57.13	57.13	57.13	57.13
Baseline	Showers (Average)	per person/day	1.16	1.21	1.16	1.21	1.16	1.21	1.16	1.21
Water Efficient Alternative	Showers (Electric)	Litres per use	44.00	44.00	44.00	40.74	44.00	39.11	44.00	35.75
Water Efficient Alternative	Showers (Mixed)	Litres per use	44.00	44.00	44.00	40.74	44.00	39.11	44.00	35.75
Water Efficient Alternative	Showers (Electric)	per person/day	1.21	1.33	1.21	1.33	1.21	1.33	1.21	1.33
Water Efficient Alternative	Showers (Mixed)	per person/day	1.21	1.33	1.21	1.33	1.21	1.33	1.21	1.33
Ownership	Baths	Per Household	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Baseline	Baths	Litres per use	84.95	84.95	84.95	84.95	84.95	84.95	84.95	84.95
Baseline	Baths	per person/day	0.63	0.58	0.63	0.58	0.63	0.58	0.63	0.58
Water Efficient Alternative	Baths	Litres per use	68.00	68.00	63.36	63.36	61.04	61.04	61.04	61.04
Water Efficient Alternative	Baths	per person/day	0.55	0.46	0.55	0.46	0.55	0.46	0.55	0.46
Ownership	Washing Machine	Per Household	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Baseline	Washing Machine	Litres per year	9111.82	9111.82	9111.82	9111.82	9111.82	9111.82	9111.82	9111.82
Water Efficient Alternative	Washing Machine	Litres per year	8987.00	8987.00	8987.00	8987.00	8987.00	8987.00	8987.00	7370.00
Ownership	Dishwasher	Per Household	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Baseline	Dishwasher	Litres per year	4460.05	4460.05	4460.05	4460.05	4460.05	4460.05	4460.05	4460.05
Water Efficient Alternative	Dishwasher	Litres per year	4460.05	4460.05	3330.69	3330.69	4460.05	2766.01	4460.05	1784.02
Ownership	Hose Attachment	%	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Ownership	High Pressure Washer	%	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Baseline	Hose Attachment	Litres per use	11.04	11.04	11.04	11.04	11.04	11.04	11.04	11.04
Baseline	Hose Attachment	Litres per year	7178.75	7178.75	7178.75	7178.75	7178.75	7178.75	7178.75	7178.75
Baseline	High Pressure Washer	Litres per use	48.46	48.46	48.46	48.46	48.46	48.46	48.46	48.46
Baseline	High Pressure Washer	Litres per year	18660.88	18660.88	18660.88	18660.88	18660.88	18660.88	18660.88	18660.88
Water Efficient Alternative	Hose Attachment	Litres per use	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78
Water Efficient Alternative	Hose Attachment	Litres per year	5707.00	5707.00	5707.00	5707.00	5707.00	5707.00	5707.00	5707.00
Water Efficient Alternative	High Pressure Washer	Litres per use	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70
Water Efficient Alternative	High Pressure Washer	Litres per year	5660.65	5660.65	5660.65	5660.65	5660.65	5660.65	5660.65	5660.65

Table 4: Fittings assumptions for each scenario

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Time Horizon for Building Regulations

It is assumed that the water fitting standards will be introduced in stages. Firstly 110 LPD is already part of the building regulations part G as an optional set of standards which some local authorities have opted for, therefore in the 110 LPD, 100 LPD, 95 LPD and 85 LPD scenarios it is assumed to be introduced in the first year as it would be a reasonable starting point.

Thereafter subsequent stricter water standards will be introduced after every 3 years. For example, the 95 LPD scenario will start with 110 LPD in year 1, then in year 4 a 95 LPD be introduced. The tables below show the LPD equivalent water standards introduced for each year and scenario.

New Build Installations Covered by Building Regulations

	No. of Years																								
Scenario	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
110 LPD	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
100 LPD	110	110	110	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
95 LPD	110	110	110	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
85 LPD	110	110	110	95	95	95	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85

Major Retrofit Installations Covered by Building Regulations

	No. of Years																								
Scenario	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
110 LPD	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
100 LPD	110	110	110	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
95 LPD	110	110	110	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
85 LPD	110	110	110	95	95	95	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85

Table 5: Assumed timeframe for introducing consumption targets for new build homes and major retrofit installations. Table displays in which year the litres per day target can be achieved based on the different scenarios.

Time Horizon for DIY Retailers

For products bought at DIY stores it is assumed that those markets will need more time to adjust to the new water efficiency standards. It is assumed the same standards will be introduced but with a 3 year delay to give the retail stores time to source and stock compliant products. It is also assumed within the first 3 years the savings achieved will be equally staggered up to 100% to illustrate the change in stock retail stores will have to go through.

Householder Installations Bought from DIY Retailers

	No. of Years																								
Scenario	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
110 LPD				110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
100 LPD				110	110	110	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
95 LPD				110	110	110	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
85 LPD				110	110	110	95	95	95	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85

Table 13: Assumed timeframe for introducing consumption targets for DIY store installations. Table displays in which year the litres per day target can be achieved based on the different scenarios

Energy Savings

These savings were calculated using the Energy Saving Trust Water Energy Calculator. Using known parameters such as the specific heat capacity of water, the temperature water is

typically heated to at different points of use, weighted average UK water heating system fuel types and efficiencies (and Northern Ireland inputs where available), the weighted average UK heating system efficiency, energy savings per product type could be calculated as kWh per litre saved. Using this factor against the total water savings per year we calculated the total energy savings in MWh for those products that will save hot water, such as water efficient taps, showers, baths, washing machines and dishwashers.

Water Bill Savings

Less than 1% of households in Northern Ireland are metered for water, therefore no direct water bill savings can be assumed.

Energy Bill Savings

These savings were calculated using a weighted average energy tariff according to the domestic hot water heating fuel mix calculated and derived by the Energy Saving Trust and the projected domestic long-term fuel prices from government's Green Book Supplementary Guidance[17]. This resulted in a weighted average energy price of 5.02p/kWh in year 1 to 6.33p/kWh in the 25th year. This was then applied to the energy savings to calculate the total domestic energy bill savings year on year.

CO2e Emission Savings

Embodied carbon savings were based on factors for water supply and wastewater treatment of 0.000118 and 0.0002509 gCO2e/litre respectively, sourced from Northern Ireland Water's data. These were applied to the water savings to calculate the total domestic embodied CO2e emissions savings.

The water heating savings were calculated using the domestic hot water heating fuel mix for Northern Ireland, calculated and derived by the Energy Saving Trust, and the projected domestic long term CO2e emission factors from government's Green Book Supplementary Guidance[18]. This resulted in a weighted average CO2e emission factor of 0.282 kgCO2e/kWh in year 1 to 0.271kg CO2e /kWh in the 25th year. This was then applied to the energy savings to calculate the total domestic energy CO2e emissions savings year on year.

Water Marginal Cost Savings

This benefit represents the cost to water companies of supplying water to homes. This relates to the capital cost of having to invest in more infrastructure and the operational cost of supplying that water year on year. A marginal cost of £109.55 per million litres was used and sourced from Northern Ireland Water.

[17] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal
[18] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal