Australia’s water efficiency labelling and standards scheme: summary of an environmental and economic evaluation

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ABSTRACT

This paper describes the outcomes of an evaluation of Australia’s Water Efficiency Labelling and Standards (WELS) scheme. WELS is a national, government-run scheme that mandates water efficiency labelling for indoor water-using fixtures and appliances. The scheme also imposes a minimum standard for some products. The evaluation considered the environmental and economic impacts of improvements in the water efficiency of WELS labelled products since the scheme’s inception in 2006 and forecast for 20 years. The study estimated water, energy, greenhouse gas (GHG) and utility bill savings as well as the costs associated with the scheme. The evaluation showed WELS to be an important component of urban water management in Australia, saving 112 GL in 2017–18, across the country, and 231 GL/year by 2036–37. The largest economic benefits of WELS came from the energy saving from reduced water heating. Over thirty years, these energy savings are also expected to reduce GHG emissions by a cumulative 53.5 MT. On average, Australians saved $A42 (US$30) per person per year in 2017–18 due to the water efficiency driven by WELS. Overall, the evaluation shows the WELS scheme to be highly beneficial for Australia with significant net benefits to the present and projected into the future.

Key words | cost benefit analysis, energy and greenhouse, stock modelling, water end-use

INTRODUCTION

The Australian Water Efficiency Labelling and Standards (WELS) scheme commenced in 2006 with the goal of improving water efficiency through the promotion and regulation of indoor water-using appliances and fixtures. Building on an earlier voluntary labelling scheme, WELS is a national, government-run scheme that makes water efficiency labelling mandatory and imposes a minimum water efficiency standard for some products.

The minimum standards side of the WELS scheme built on significant advances that Australia had made in the development of the dual-flush toilet and the subsequent regulation of a minimum standard for toilet flushing in the early 1990s. As well as for toilets, WELS applies a minimum water efficiency standard to washing machines.

The labelling side of the WELS scheme in Australia covers a range of plumbing products and appliances including taps (faucets), toilets, urinals, showerheads, washing machines, dishwashers and flow controllers. It is complemented by the voluntary ‘smart-approved water-mark’ scheme, which covers water-using devices such as irrigation and other outdoor water-use equipment. WELS was modelled on a successful mandatory energy-rating scheme that had operated in Australia for some years.

A number of water efficiency labelling schemes exist around the world, however, unlike WELS most are voluntary. There is currently a renewed interest in examining their level of success and the challenges involved in implementation. This interest coincides with efforts to develop a new
International Stands Organisation (ISO) standard for water efficiency labelling. The new international standard is expected to promote and improve water efficiency across the globe and make it easier for new countries to implement a water efficiency labelling scheme.

This paper describes the outcomes of an evaluation of the environmental and economic impacts of the WELS scheme by the Institute for Sustainable Futures (ISF) at the University of Technology Sydney (ISF 2018). The study was commissioned Australian Department of Agriculture and Water Resources (DAWR) which currently runs the WELS scheme for the Australian Government. The study aimed to provide the government with information of the impacts of WELS to feed into a periodic review of scheme that is legislatively required.

BACKGROUND

The WELS scheme is mandated by the Water Efficiency Labelling and Standards Act 2005 (WELS Act), and supported by both national regulation and legislation in each Australian state and territory. WELS requires all water using products covered by the scheme that are imported or manufactured in Australia to be registered and labelled before they are sold or supplied. The WELS Act allows for a compliance system that includes penalties when appropriate. Water-use information provided on the WELS label includes a star rating (with more stars being more water efficient) and usage information in litres per minute, litres per flush or an equivalent. Information for consumers, product manufacturers, and retailers is readily available on the WELS website, http://www.waterrating.gov.au/.

When WELS was introduced, there was widespread industry support for a legislated, mandatory, government-run scheme. Its introduction coincided with the worsening of a severe and prolonged drought in Australia, the ‘Millennium Drought’. The drought period saw WELS labelling become one of a suite of demand-side policies and measures brought in by governments and water utilities to reduce demand and improve water security across the country. The extensive demand management programs by water utilities and state governments in the Drought commonly involved the replacement of inefficient devices with more efficient models. These programs generally relied on WELS star ratings for their product specifications. The intensive drought response efforts continued in many regions until 2010.

Similarly, state government regulations introduced for sustainable building and plumbing, draw on WELS star ratings. For example, the state of New South Wales (NSW) introduced a requirement that all new dwelling and significant additions needed to be designed to use between 20% and 40% less water via its BASIX regulation and online planning tool. The tool accounts for the WELS star-ratings of appliance and fixtures to be installed the dwellings to calculate the required savings.

METHOD

Given the genesis of the WELS scheme in the Millennium Drought and in a water management context of many local programs, the evaluation of impacts of the scheme has taken a broad view. The evaluation considered the environmental and economic impacts of improvements in the water efficiency of WELS labelled products. This means that the costs and benefits of the demand-side policies and measures that worked in concert with the WELS scheme, particularly in the Millennium Drought, are included in the evaluation. The interlinkages and dependencies between WELS, the drought context, and related programs confound efforts to attribute a proportion of water efficiency savings to the WELS scheme alone. As a result, the study presents an evaluation of ‘WELS and associated measures’ since the scheme’s inception in July 2006 to the end of the financial year 2017–18 and then a forecast to end of June 2037.

The economic and environmental evaluation of WELS built on the approach and methodology of a previous studies of the scheme’s environmental impact in terms of household water consumption, energy use and GHG emissions (Fyfe et al. 2015) and an earlier study of its relative cost effectiveness (Chong et al. 2008). The methodological additions made in this study included:

- changing the stock modelling approach so it was based on WELS star bands
- developing a full hot water heater stock models to estimate the energy use by fuel type and associated GHG emissions and bill impacts over time
conducting a cost benefit analysis (CBA) of the scheme
including a review and collation of all scheme costs
and additional economic benefits
conducting a state-by-state analysis of reductions in water
consumption, energy use, GHG emissions and utility
bills.

The analytical approach for the evaluation started with
sales and stock data for each water-using product. This infor-
mation was used to build stock models for each product
followed by a water ‘end-use’ model to forecast water
demand. The water end-use model was also employed to
estimate hot water use. A separate stock model of water heaters was used to estimate energy use, by type, for water
heating. The energy-use forecasts drove GHG estimates
that were based on difference in emissions factors for each
state. The water, energy and GHG savings attributable to
the WELS scheme (and the associated measures it under-
pins) were calculated by taking the difference between the
‘with WELS’ and ‘without WELS’ scenarios. The approach
is illustrated in Figure 1.

Also illustrated in Figure 1 is the CBA. Physical models
for water and energy derived savings in utility bills, with utility prices paid by consumers used as a proxy for valuation. The differences in prices for water and energy in the various
states were accounted for in the modelling. These bill
savings together with estimates of the value of GHG emis-
sions and estimates of the range of costs resulting from the
WELS scheme and associated measures, were included in
the CBA.

The strengths of the evaluation approach are that it
incorporates stock and sales data from multiple sources
and does not artificially separate the effect of WELS from
other programs run at the time. The key weakness of the
approach is that there is not control group of non-partici-
pants in the scheme for comparison (as the scheme was
mandatory and national). The methodology is a variant of
a pre-post savings estimation technique. The key uncertainty
with pre-post analyse is the level to which external factors,
other than the program itself, impacts estimated savings
(Todd et al. 2012). A number of external factors, such as
weather, drought restrictions and change in mix of dwelling mix, are removed from the analysis by modelling indoor
water consumption. However, other factors like the level
of behaviour change due to the Millennium drought
remain as uncertainties in the analysis.

Water end-use modelling

Stock and end-use models generate estimates of total water
use and hot water use. Stock modelling keeps track of the

Figure 1 | Approach to analysis for evaluation of WELS scheme.
efficiency of clothes washers, dishwashers, showers, taps, toilets and urinals in Australia. The stock of each ‘star rating band’ (including unrated models) of each fixture or appliance was accounted for over the period modelled. The stock of each fixture and appliance grows with the number of dwellings and at the end of each fixture or appliance’s lifetime of, it is replaced by a new model, chosen according to sales data for that point in time. Residential and non-residential water use were calculated separately. Non-residential water use included urinals, toilets and basin taps.

The data used to feed the stock models included: stock survey data from various locations, sales data, sales estimates from interviews with suppliers (who were also asked about costs and impacts of the scheme) and regional new residential building data for one state (New South Wales where the BASIX scheme requires registration of this stock data in new developments). The best data were for whitegoods (clothes washers and dishwashers) as national annual sales data was able to be sourced. Estimates of plumbing products stock were based on partial sales data from large retailers, interview data, stock surveys conducted in various regions and the new residential building data from New South Wales.

The water used by each fixture or appliance was calculated using average usage behaviour (for example, minutes of showering per person per day, or average loads of washing per person per day) and the average efficiency of the stock of fixtures at that point in time. This general approach to water modelling – an end-use model to estimate water consumption for each indoor appliance and plumbing fixture – was similar to previous evaluations of WELS (Wilkenfeld 2004; Chong et al. 2008; Fyfe et al. 2015).

Table 1 provides a summary of end-use data used in the modelling (with the exception of urinals).

In Table 1 the flow rates for star rates are averages drawing from the WELS Standard (Standards Australia 2016) with effective flow rates being based on the same assumptions on ‘throttle back’ from maximum flow as Fyfe et al. (2015). Frequency and duration assumptions varied between states and with the data drawn from Water Corporation (2010), Redhead et al. (2015), Willis et al. (2015), Beal & Stewart (2014) and Roberts (2017). ISF (2018) provides details on the application of this data within the models.

Table 1 | Summary of end use and WELS rating data and assumptions used in water demand modelling

<table>
<thead>
<tr>
<th>Flows</th>
<th>Showers Max L/min</th>
<th>Showers Effective L/min</th>
<th>Taps Max L/min</th>
<th>Taps Effective L/min</th>
<th>Toilets Average L/flush</th>
<th>Cloth. Wash Average L/wash</th>
<th>Dish wash Average L/wash</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 star</td>
<td>20</td>
<td>11.8</td>
<td>20</td>
<td>9</td>
<td>12</td>
<td>176</td>
<td>30.2</td>
</tr>
<tr>
<td>1 star</td>
<td>16</td>
<td>11.2</td>
<td>16</td>
<td>8</td>
<td>8</td>
<td>154.9</td>
<td>20.5</td>
</tr>
<tr>
<td>1.5 star</td>
<td>12</td>
<td>9.1</td>
<td>12</td>
<td>7.2</td>
<td>6.5</td>
<td>135.9</td>
<td>16.9</td>
</tr>
<tr>
<td>2 star</td>
<td>9</td>
<td>6.9</td>
<td>9</td>
<td>6.3</td>
<td>5.1</td>
<td>104</td>
<td>11.5</td>
</tr>
<tr>
<td>3 star</td>
<td>7.5</td>
<td>6.5</td>
<td>7.5</td>
<td>6</td>
<td>4.4</td>
<td>79</td>
<td>7.9</td>
</tr>
<tr>
<td>4 &amp; 4E star</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td></td>
<td>6.87</td>
<td>6.5</td>
<td>6.5</td>
</tr>
<tr>
<td>5 star</td>
<td>5.4</td>
<td>3</td>
<td>5.1</td>
<td>59.7</td>
<td>3.2–5.2</td>
<td>2.7–4.0</td>
<td></td>
</tr>
<tr>
<td>6 star</td>
<td>4.5</td>
<td>4.5</td>
<td>4.4</td>
<td>4.4</td>
<td>3.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>0.87–0.82</td>
<td>6.8</td>
<td>3.5–4.3</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
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<tr>
<td>/dwelling/wk</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>3.2–5.2</td>
<td>2.7–4.0</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Duration (ave)</td>
<td>5.72–6.9 mins.</td>
<td>23 sec</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>
The following refinements to stock and end-use modelling methods were made for the current study:

- Each Australian State and the Northern Territory was modelled separately.
- Stocks and sales of all product types were categorised and modelled individually by star rating bands as opposed to a simple efficient/inefficient split used earlier studies for most product types. See Figures 2 and 3 for an example of how star band based stock modelling was conducted for the study. The ‘with WELS’ and ‘without WELS’ scenarios are compared.
- Recent sales data included retail data were used to improve sales projections.
- User behaviour was updated with recent end-use studies, and distinctions between different states in behaviours were included.

As shown in Figures 2 and 3, the comparison of two scenarios (for showerheads only) enabled savings attributable to WELS to be estimated. These are:

- A ‘with WELS’ case constructed to reflect changes that occurred following inception of the WELS scheme. This is a forecast and hindcast of the current consumption levels. It combines sales data obtained from interviews with purchased sales data, as well as end-use data available from end-use and stock studies conducted across Australia in recent times. This scenario starts in 2006 (indicated on the figure with a line) and the introduction of WELS. It includes population and household growth to 2036–37.
- A ‘without WELS’ case constructed to reflect the changes already in effect in 2006 when the scheme commenced, but with water use continuing as it would have without the scheme. This scenario includes all existing behaviours, policy settings and sales preferences as of 2006, projected with population and household growth to 2036–37. It is assumed that the previous voluntary water efficiency labelling scheme, which existed in Australia before the WELS, continued.

The stock models (in Figures 2 and 3) start before the period of evaluation (2006–07 to 2036–37), and in the period before 2006, both scenarios are the same.

**Energy and greenhouse savings**

A hot water system stock model was created that included the common hot water system types (electric resistance, electric heat pump, gas instantaneous, gas storage, solar gas boosted, and solar electric boosted) and the most...
widely used fuel types (electricity and gas). Stock data came from national stock survey data published by the Australian Bureau of statistics (ABS) and cross-checked with new residential building data in New South Wales.

The model of hot water system sales for new dwellings was fitted to stock survey data for each particular state or territory from ABS hot water system survey results (available for 2005, 2008, 2011, 2012 and 2014). Efficiencies and lifetime assumptions for hot water heater types, used in modelling, were taken from Wilkenfeld (2009).

It was assumed that the temperature of hot water was 50 °C, which is the maximum allowed to prevent scalding. Shower temperature was assumed to be 40 °C (slightly above body temperature) and the average tap temperature was assumed to be 30 °C (acknowledging that hot water is not always used). The energy required to heat water depends on the starting temperature, which varies with location. The temperature values for capital cities were used (Energy Efficient Strategies 2008), with the average cold water temperature in each capital city being used for the whole of that state.

The greenhouse intensity of electricity in Australia was available from 1989 to 2017, and for natural gas, the greenhouse intensity factors were available from 2012 to 2017 (DEE 2017). The greenhouse intensity of natural gas from 2006 to 2012 was assumed to be the same as the 2012 values. Future GHG intensities were assumed to decrease towards 2036 in line with the Australian Government’s commitment to meet the 2015 Paris Agreement on Climate Change (UNFCCC 2015). This gave an approximate 30% reduction in intensity in 2036 compared to 2006 levels for all energy sources. The exception was for electricity in South Australia, where the intensity was already low and so a 30% decrease was assumed from 2012.

**Cost benefit analysis**

This study attributes all improvements in water efficiency for WELS rated products to the ‘with WELS’ case, in comparison to the base (without WELS) case and counts these as benefits. This approach requires an equivalent consideration of the costs with both WELS scheme costs and costs
associated with other measures that have impacted water efficiency also counted. The cost estimates included in the study therefore result directly from the labelling and minimum standards aspects of the WELS scheme, and the costs of associated measures particularly demand management programs run by water utilities and state governments.

The economic appraisal in this study is unusual in that it seeks to evaluate a regulatory mechanism, the WELS scheme, which has been in place for 12 years, including the current year 2017–18, and no changes are proposed at this time. It also seeks to project the future impacts of the scheme for a further 19 years (making a 20 year forecast including 2017–18). The total analysis period is therefore 31 years, from July 2006 to July 2036. It includes estimates of past, current and future costs and benefits. The historical impacts due to the WELS scheme are estimated using collated data and modelling, with all costs and benefits converted to real $2017–18 dollars based on the historical inflation rate in Australia (ABS Cat No 6401.0). Estimation of future impact is based on projections of known trends in water and energy savings together with trends in prices. Future costs and benefits are discounted to present values ($2017–18 dollars) based on the 7% discount rate for the central analysis. Sensitivities were conducted at 3% and 10% based on Australian Government guidance (Australian Government 2016a). When reported, the total figures for cost and benefit are a sum of the past values (in real terms), the current values and the discounted present values of the future period.

Benefits

Value of water savings. The value of water saved as a result of WELS has been estimated using the volumetric retail price of water paid by customers across Australia. Prices were drawn from a national performance reporting data set collected by the Australian Bureau of Meteorology (BOM 2018). This approach is based on the assumption that retail water prices represent a reasonable approximation of the long run marginal cost (LRMC) of water supply in each region across Australia. It is therefore the value of conserved water. This is a reasonable assumption in most Australian jurisdictions (IPART 2015; Murray & Tooth 2015). A sensitivity analysis on water price was conducted using the potential difference in LRMCs in a scenario without WELS.

Value of energy and greenhouse gas savings. Energy savings have been estimated by ‘fuel’ type (electricity or natural gas) and by state. The estimated value of savings was based on expected customers bill impacts. Differences in residential electricity or natural gas prices across Australian states have been accounted for in the historical prices, and in future projections using national data sets for electricity (Jacobs 2017) and natural gas (Oakley Greenwood 2018). However, a level of uncertainty in the trajectory of future energy prices exists. This seems a particular issue for natural gas where current differences among the states are high. The impact of a shift toward higher or lower natural gas prices was therefore tested in the sensitivity analysis.

Greenhouse gas savings were derived from the WELS scheme’s effect on reduced water utility energy use in the supply of water, and from the reduced energy use in water heating with high water efficiencies. The energy and GHG savings from lower hot water use will far exceed the savings associated with reduced potable water supply. The value of GHG emissions in the period of analysis remains uncertain and a number of approaches to valuing emissions can be taken in the Australian context. This study developed a ‘base case’ - derived from EU market prices and Jacobs (2017) projections for the Australian electricity market to 2030, a ‘low case’ and ‘high case’ based on the costs of carbon to meet Paris commitments globally in all sectors (CPLC 2017). This is between US$60 and US$100 per tonne of CO2-e. In all scenarios, the historical policy of carbon pricing in Australia during the period 2013 and 2014 is accounted for, in order to avoid double counting additional GHG prices with the electricity price during that period.

Costs

The scheme administration costs used in the analysis were provided by DAWR, drawing actual budget data and material provided in the WELS scheme strategic plan for 2012–15 and strategic plan 2016–17 to 2018–19 (Australian Government 2012, 2016b). The direct costs of the scheme
have typically been just under $2 million per year (US$ 1.44M). For the analysis, future costs are projected as increasing at a nominal rate of 4% per year, on the advice of DAWR.

Data on supplier costs were gathered via interviews. Based on the interviews, cost estimates for the following two compliance activities (on top of registration fees) were included in the CBA analysis:

- cost of administration and additional testing per registration which varied from A$3,000 to A$9,000 (US $2,150–$6,500) dependent on product type
- cost of labelling each product or appliance (between A $0.05 and A$0.15).

The estimates of these costs, particularly the administration and testing costs, may have been high as producers and suppliers did not tend to separate the WELS related costs from other labelling and compliance costs for their products.

For this study, the costs of demand programs during the Millennium Drought were based on costs reported by Sydney Water in its Water Efficiency Report (Sydney Water 2012). These costs apportioned were across the population serviced by Sydney water to give per capita costs per year. To estimate costs across the country, these per capita figures were used as a proxy for investment in demand management during the Millennium Drought in those regions impacted by significant water scarcity. Because Sydney Water, like other large metropolitan utilities, was highly active in demand management during the drought, these costs may be an overestimate of the scale of investment in some non-metropolitan areas.

Non-quantified costs of scheme

There are views that industry unfairly carries the financial burden of the WELS scheme through registration fees, while communities reap the benefits through greater water supply security and reduced spending on water infrastructure. A number of interviewees also stated that while the direct WELS costs have an obvious financial impact, especially registration fees for smaller businesses, there are also hidden costs and some potentially perverse outcomes for market competition that result from the scheme.

RESULTS AND DISCUSSION

Table 2 shows the results of the modelling with estimates of the annual savings in 2017–18, 2026–27 and 2036–37. Figure 4 shows the breakdown of these water savings by product types over the period of analysis.

Table 2 shows that in 2017–18 the estimated water saved by WELS labelled products was 112 GL/year across Australia. These savings are anticipated to grow to 185 GL/year in 2026 and 231 GL/year in 2036. Figure 4 shows the largest proportion of the savings come from taps, followed by showers and then clothes washers. Over the period a growing proportion of savings is coming from clothes washers, dishwashers and toilets.

Table 2, shows energy savings of 13 PJ/year energy in 2017–18. Natural gas can be seen to be greater proportion of with 7.5 PJ/year saved, compared to 5.5 PJ/year for electricity. This saving is the equivalent of over 2.1 million barrels of oil in 2017–18. The vast majority of the energy saving due to WELS and associated measures, over 97%, comes from avoided need for water heating by customers with more efficient fixtures (taps and showers) and in appliances. The total energy saving is anticipated to grow to 22.5 PJ in 2036 with the proportion of natural gas slightly increasing over this time.

The energy savings in turn translate into GHG savings. Without the increase in water efficiency in WELS, products since 2006 an additional 1.92 MT in GHG emissions would have been released in 2017–18 (see Table 2). This would be the equivalent of adding an additional 770,000 new cars to Australian roads in that year. Interestingly GHG emission savings from WELS, in its current form, are expected to peak around 2031 at 2.51 MT of CO2-e/year before

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Savings due to WELS and associated measures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2017–18</td>
</tr>
<tr>
<td>Water saved (GL/yr)</td>
<td>112</td>
</tr>
<tr>
<td>Electricity saved (PJ/yr)</td>
<td>5.51</td>
</tr>
<tr>
<td>Gas saved (PJ/yr)</td>
<td>7.51</td>
</tr>
<tr>
<td>GHG avoided (Mt CO2-e/yr)</td>
<td>1.92</td>
</tr>
<tr>
<td>Annual bill savings in year ($billion)</td>
<td>$A1.05 ($US0.76)</td>
</tr>
</tbody>
</table>
declining somewhat. This is due to the trend towards more water heating by natural gas and projections in relation to GHG intensity of the energy supplies in Australia (with an increasing level of renewable power in the electricity grid).

As shown in the snapshots in Table 2 the current annual utility bill savings for households and businesses are A$1.05 billion dollars per year (US$756M). This annual saving is anticipated to increase 2.6 times (in nominal terms) by 2036. Electricity bills are the largest proportion of the saving, followed by natural gas and water bills. Currently, 75% of bill savings come from avoided energy use due to hot water savings. Each person in Australia is currently saving an average of A$42 (US$30) per year due to the increase in the water efficiency of WELS rated products since the scheme’s inception. By 2036, the predicted bill savings nearly double per person (in nominal terms).

Table 3 shows a summary of the costs and benefits resulting from the WELS scheme and associated measures. Past and current values are combined in the table. Past costs have been inflated to the current year (2017–18) dollars and future costs are discounted to the present value. The results show total benefits over A$24 billion (US$17.3 billion) with costs under A$1 billion (US$ 603M) across the period of analysis. This gives a net benefit estimate of A$23.4 billion (US$16.8 billion) for the first period from 2006 until 2026. The table shows that electricity savings are the largest benefit in dollar terms followed by natural gas savings and water.

Large costs were incurred for demand management programs in Australia’s Millennium Drought between 2006 and
2010. These measures associated with WELS enhanced savings due to water efficiency but also had a significant cost at the time. Supplier costs in testing and administration (in addition to WELS scheme registrations fees) are the next largest costs incurred as a result of the scheme.

High benefit cost ratios, as shown in Table 3, were maintained with sensitivity analyses of natural gas prices, GHG emission costs, water prices and discount rates. In all cases, the benefits of the scheme were significantly higher than its costs and this was the case for both the past and current period from 2006 to the present, and the future period to 2036.

Figure 5 shows the impact of WELS on total water consumption by WELS rated products. This is a reasonable proxy for indoor water use in Australian households and businesses (excluding commercial applications like laundries and commercial dishwashers). Significantly, the graph in Figure 5 shows total water use in WELS rated products has recently passed a low point and is now growing. By 2028 it can be expect to return to its previous peak of 1200 GL per year across the country. After this time water use is projected to continue to grow. This points to a potential for new measures that might complement WELS and improve water use efficiency further in Australia. Particularly in jurisdictions with high population growth, new measures such as ultra-low flush toilets might be installed in new buildings to limit the growth in total demand (see Fane et al. 2018 for worked example).

CONCLUSIONS

The evaluation has shown the WELS scheme in Australia to be an important component of urban water management in the country. The reductions in water demand can be expected to have delayed supply augmentations in multiple regions and generally improved water security in urban areas. The scheme, and related measures, by driving indoor water efficiency in Australia, are responsible for significant energy savings and thereby avoided GHG emissions.

However, despite its success, the WELS scheme in its current form is not anticipated to keep pace with population growth in Australia (see Figure 5). The modelling of stock and sales indicates a plateauing in the water efficiency of products sold in years to come. It can be concluded that for a continuation of improvement in water use efficiency
of WELS rated products, new initiatives beyond labelling would be needed. These might be in the form of incentive programs run by water utilities, new regulations on building or plumbing or raising the minimum water efficiency standards under WELS.

For jurisdictions outside Australia, this evaluation demonstrates the benefits of a national, government-run scheme that mandates water efficiency labelling for indoor water-using fixtures and appliances and included minimum standards. The results show the benefits of such a scheme vastly outweigh the costs. These benefits are for urban water supply and security, to economy in general and for avoiding GHG emissions. The size of the benefits found, even with the uncertainties within the analysis, should promote governments internationally to consider similar schemes in their own regions.

**ACKNOWLEDGEMENTS**

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