HWA response to the Call for evidence a smart, flexible energy system

This submission is from the Hot Water Association (HWA) a not for profit trade association, the leading body in domestic hot water storage and, through cooperation and partnerships, to support, drive and promote the sustained growth and improvement of standards within the entire domestic hot water industry.

Q1 Have we identified and correctly assessed the main policy and regulatory barriers to the development of storage? Are there any additional barriers faced by industry? Please provide evidence to support your views

The call for evidence focuses on issues around lithium ion batteries, which is a narrow definition of a battery. Hot water storage is a means of storing energy for use later, however it is in the form of hot water. Hot water generation will be one of the main uses for energy in the home in the coming decades. Therefore this narrow definition would not address some of the policy and regulatory barriers to storing hot water as an energy source.

In the last ten years sales of domestic hot water cylinders has fallen by over 50%. "Over the last two decades, the use of combination boilers for central heating have increased. Such boilers provide hot water from the central heating without a separate tank and have increased dramatically from 12% in 1996 to 52% in 2014. This has meant that fewer homes have a hot water tanks, down from 63% to 38%."[1].

The government wants to reduce energy use in the home. As we reduce the amount of energy needed for space heating the proportion of energy used to generate hot water will stay at similar levels to today. If we also move to lower temperature heating devices, such as heat pumps, then the energy use needed to generate hot water will increase. Heat pumps need a hot water store, they cannot generate hot water on demand.

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[1] English Housing Survey Energy Report, 2014

Therefore the current policy framework needs to look to encourage the retention of hot water stores. It also needs to encourage new homes to be built with hot water storage to make them renewable ready. If they are not then they will need to be retrofitted at a later date which will be more expensive to the householder.

The call for evidence's narrow definition also leads it to not take into account how hot water storage could also be used by storing electrical energy for use later. A common hot water cylinder of approximately 180 litres can store around 800 kWh of electricity which is converted into hot water. This is approximately an average homes daily use. We believe that more research is needed into the potential use of hot water storage for demand side management. Close to 40% of homes have a store and so the park of available appliances is already in situ unlike with expensive 'battery' technology.

Nearly all hot water cylinders have an electrical immersion heater inputted into the store to provide a secondary source of heat. This is the primary source for homes with no natural gas or oil connection. These immersion heaters could be 'smart' enabled to be used by national grid to manage demand by transferring electricity to the stores when needed. This energy will then be used by the household in terms of hot water.

We believe there is large potential to use an existing appliance to meet the needs of the call for evidence, but it needs to be recognised and policy needs to be developed to address the falling sales, lack of household demand and development of smart immersion heaters. All these things are easier and cheaper to achieve than developing and selling large battery storage for homes.

Q6. Do you agree with any of the proposed definitions of storage? If applicable, how would you amend any of these definitions? Please provide evidence to support your views.

We do not agree with the definitions because they define storage as a device that reconverts energy into electricity.

As the above answer details, energy storage does not always generate electricity. The definition should be amended to ensure that all types of storage, including hot water storage are included.

Camden House, Warwick Road, Kenilworth, CV8 1TH
T: +44 (0)1926 513777 **F:** +44 (0)1926 511923
E: mail@eua.org.uk **W:** www.eua.org.uk

Q25 Can you provide evidence to show how existing Government policies can help or hinder the transition to a smart energy future?

HWA believes that hot water storage will be vital in developing a smart energy future. However there are no existing policies that reward or encourage the installation of hot water stores.

We believe that:

1. All new build properties should have a hot water store. This will enable them in the future to be fitted with a smart immersion heater to facilitate demand side management of the electricity grid. They will also make them renewable ready to work alongside a low temperature heating device such as a heat pump.
2. SAP and the Energy Related Performance directive (ERP) should be remodelled to provide a reward for installing a hot water store. Currently they do not reward homes for installing a storage device. This simple move would encourage homes to make more informed choices. This would reflect the benefits to the grid of storing hot water, currently these are not recognised.

Q27 Do you have any evidence to support measures that would best incentivise renewable generation, but fully account for the costs and benefits of distributed generation on a smart system?

HWA believes there are substantial benefits of using a solar diverter alongside a hot water cylinder, in order to maximise a householder's return on investment having installed solar photovoltaic (PV) panels. This can help encourage homes to install PV panels and help them to maximise their return on investment.

The savings have been calculated using a bespoke model that calculates how much a typical household would pay for hot water, before using solar PV generation data to estimate how much of this cost could be offset by using "spare" electricity from their solar PV array.

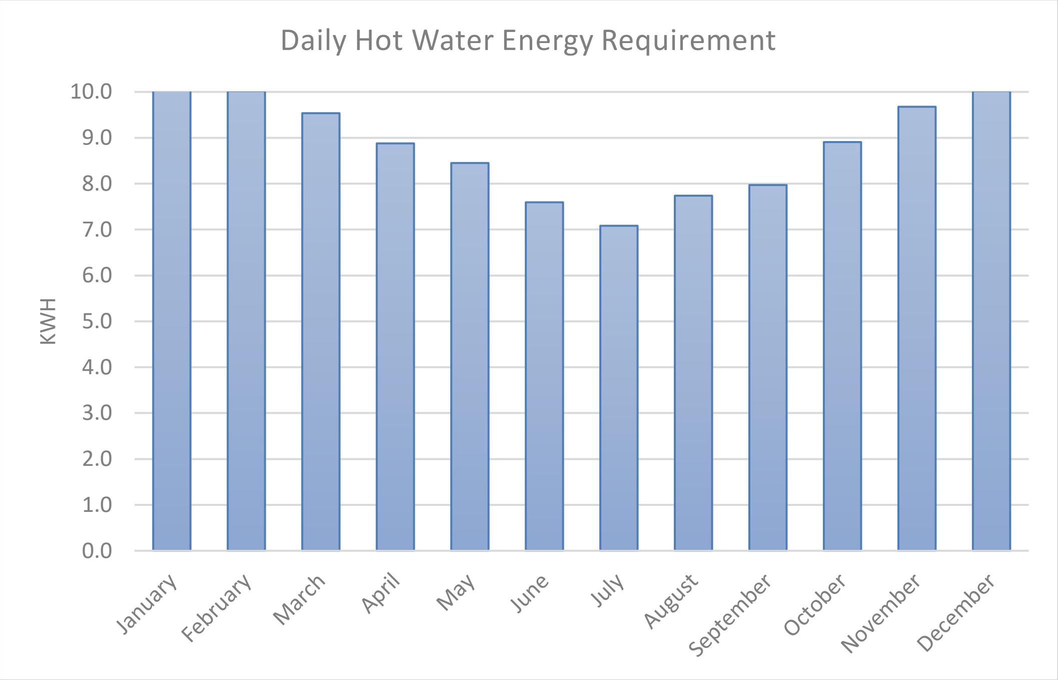
<u>Methodology</u>

<u>Modelling Hot Water Demand</u>

Daily hot water energy requirements were estimated using the Building Research Establishment's Domestic Energy Model (BREDEM) 2012 methodology. For a given number of occupants, this methodology uses an estimate of the number of showers and baths taken each day to calculate how much hot water would need to be produced to satisfy the needs of these occupants. For the purposes of this calculation, it is assumed that the property is home to 2.4 occupants.

By taking into account the temperature of incoming water[2] and the temperature to which it is heated, the energy content of the heated water can be calculated for each day of a representative year. In addition to this, water heating system losses (in the form of distribution, storage and primary pipework losses) impose a further energy requirement upon the hot water system. It is assumed that the property has a 180L hot water storage cylinder.

Adding the above together provides the following estimate of daily energy requirements for hot water in each month:



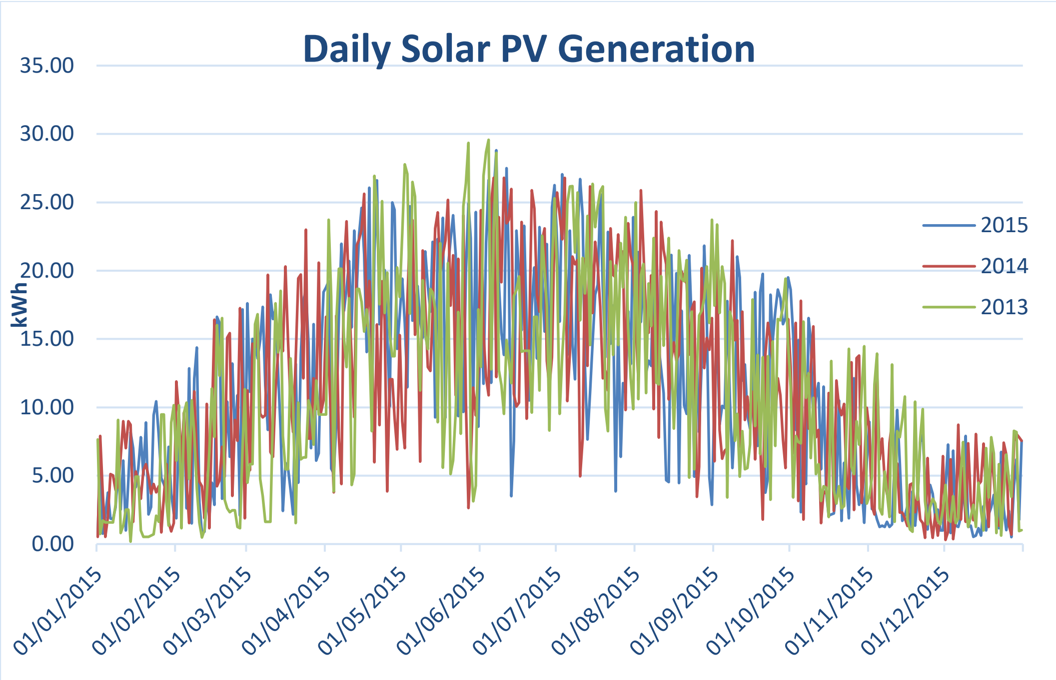
Solar PV Generation Data

Generation data for a UK solar PV installation was provided to the HWA by Viridian Solar. The data related to the 44.5 kWp installation on Viridian's factory roof[3] and detailed the amount

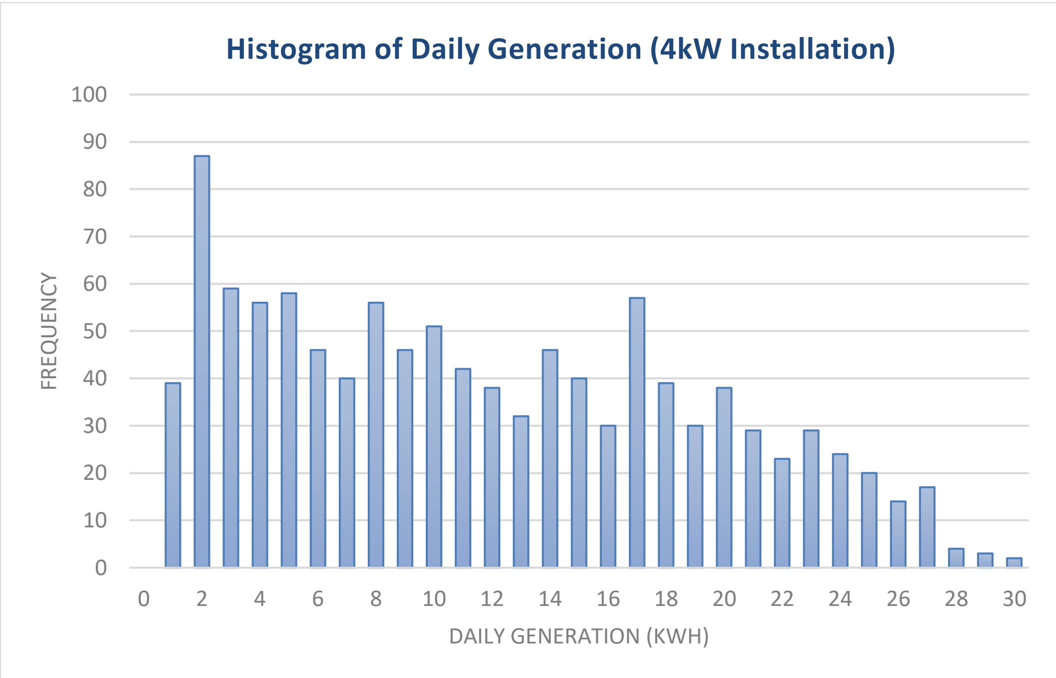
[2] BREDEM assumes the temperature of incoming water is higher in summer which explains the drop in energy demand for hot water at that time of year. Most new cylinders installed will be mains pressure and therefore the water feed at more constant (and lower) ground temperature. This may mean there are greater savings to be made with unvented systems.
[3] Sout-West facing, tilt angle 35 degrees, shading – none or very little.

of electricity generated from this installation on each day between 1st January 2013 and 31st December 2015. A 44.5 kWp installation is far larger than the typical domestic PV installation, so these generation data were scaled to indicate the output from a 4kWp installation.

The following line graph demonstrates how daily solar generation varies from day-to-day throughout the year. As would be expected, a highly seasonal pattern emerges:



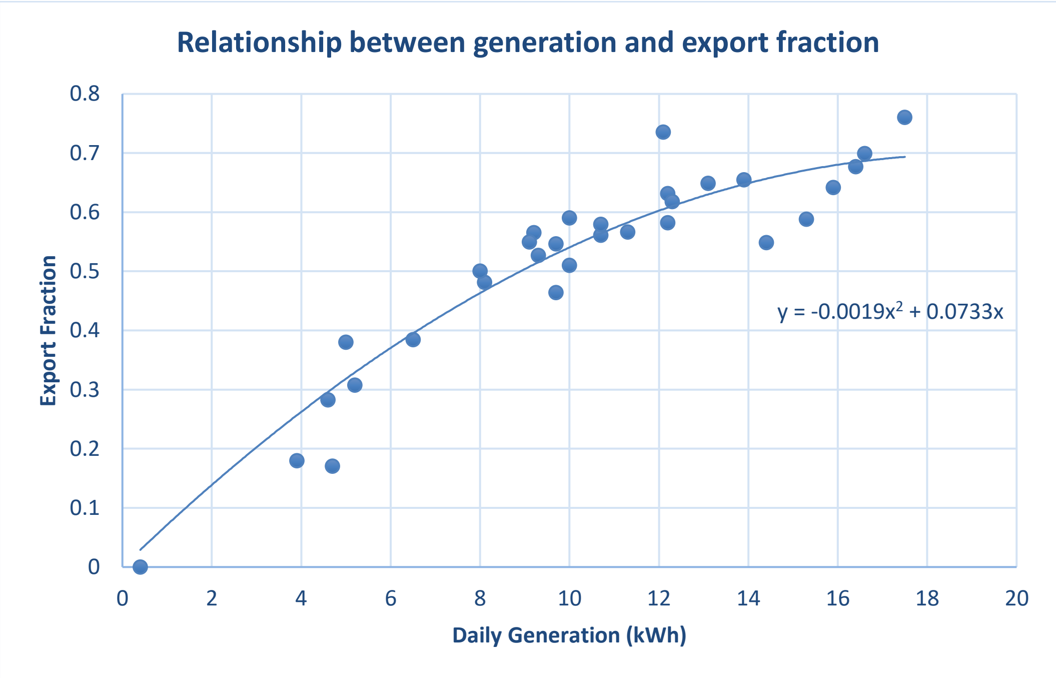
The following histogram shows the frequency of different levels of daily generation.



<u>Estimating Export Fraction</u>

Although Feed-in Tariff (FiT) export payments are currently paid on the basis that 50% of generated electricity is exported, this is unlikely to be true in reality. It stands to reason that a higher level of generation should result in a higher export fraction, since household electricity consumption is largely intransigent to solar irradiation (this may not be true in hotter countries where domestic air conditioning is more prevalent).

A second data set supplied by Viridian Solar provided information from real household solar installations on the level of solar generation and the percentage that is exported. Using these it was possible to construct a model that allowed the estimation of the export fraction for a given level of generation. The graph below shows the relationship between generation and the export fraction.



A quadratic line of best fit was then fitted to these data (with the intercept set to zero). Using the formula associated with the line of best fit, it is possible to estimate the export fraction for any given level of generation. This is demonstrated in the table below:

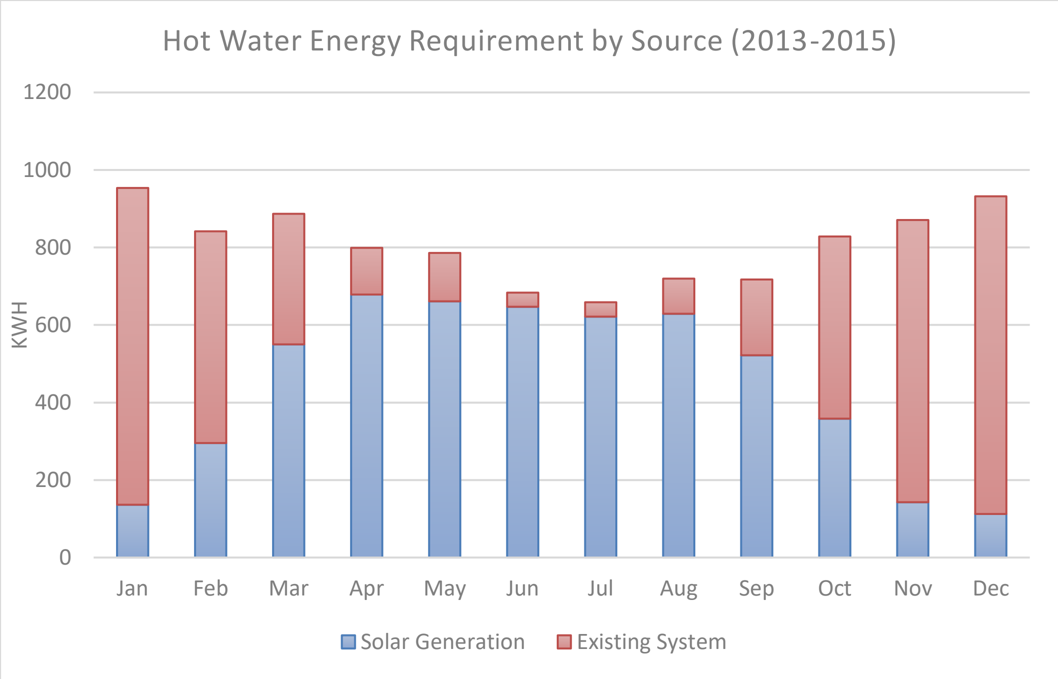
Generation (kWh)	Export Fraction

0	0.00%
2	13.90%
4	26.28%
6	37.14%
8	46.48%
10	54.30%
12	60.60%
14	65.38%
16	68.64%
18	70.38%
20	70.60%

Estimated Savings

Using a solar diverter, it is assumed that any electricity that would have been exported is used to instead meet the household's hot water demand.

On some days, excess solar electricity is sufficient to meet all of the energy requirements for hot water. On others, the existing heating system has to meet some of the additional energy requirements. The graph below shows the average proportion of the hot water energy requirement that could have been met by each energy source in each month over the three years for which the solar generation data were available.



In the first instance, the cost of meeting hot water demand using a gas boiler or an electric heating system (boiler or immersion heater) is calculated. For a household using a gas boiler the following assumptions are made:

- Hot water efficiency of 80%
- Gas price of 4.18 p/kWh

For a household using electric heating, the following assumptions are made:

- Efficiency of 100%
- Electricity price of 13.86 p/kWh[4]

In the second instance, the cost of meeting hot water demand using a solar PV array and power diverter alongside the existing heating system is calculated. The table below demonstrates the costs of each situation and the resulting savings:

[4] This could be reduced to 7.21p if using economy seven, however this is not representative of the majority of UK households.

		2015	2014	2013
Gas	**Original cost**	156.53	156.53	156.53
	Cost with PV and Diverter	67.63	65.61	71.33
	Savings	**88.91**	**90.93**	**85.21**
Electricity	**Original cost**	415.22	415.22	415.22
	Cost with PV and Diverter	179.38	174.03	189.20
	Savings	**235.84**	**241.19**	**226.02**

For households using gas to heat their hot water, a saving of approximately £90 could have been made in each of the last three years. For those using electricity, the saving would have been between £220 and £240.

Conclusion

This study only considers the benefits to the homeowner, but it would be remiss to conclude without mentioning some of the wider benefits of hot water cylinders in a future of widespread renewables. The unpredictable nature of renewables means that the challenge of balancing the grid will become more difficult as renewables play a larger role in the electricity mix. Finding economic methods of storing this electricity will be a key component of managing the new electricity system.

This study suggests that the use of a solar diverter alongside an existing hot water storage cylinder has the potential to produce significant savings. Given the relatively low initial cost of a diverter (~£200-£300), payback could be achieved in under three years.

Contact: Isaac Occhipinti, Head of External Affairs, HWA, Isaac@eua.org.uk