



Discussion Paper Outlining the Technical Solution of a
Flue Gas Heat Recovery System with a Thermal Store



Contents

Overview	3
Introduction	4
How GasSaver™ Works	5
Space Heating vs Domestic Hot Water	6
GasSaver™ Technical Overview	8
GasSaver™ Test Data.....	9
GasSaver™ Water Savings.....	10
GasSaver™ Features & Benefits.....	12
GasSaver™ Deployment.....	13
Existing Combi-Boiler Retrofit & Replacements	13
New Builds	13
Regulation Changes.....	13
UK Boiler Plus & GasSaver™.....	13
More on UK Boiler Plus	14
UK SAP Analysis & Costs Savings.....	15
RdSAP Return On Investment	16
DISCLAIMER.....	16

Overview

Flue Gas Heat Recovery (FGHR) systems have been widely available over the past decade and their benefits are understood by industry stakeholders and more discerning consumers.

FGHR devices recover excess heat from a boiler's flue and put this recovered energy to use by pre-heating the Domestic Hot Water (DHW) cold water feed for both combination boilers and system boilers.

What is less well understood is that FGHR systems fall into two distinct categories – those with a **Thermal Store** (“**Stored FGHR**” such as the Canetis GasSaver™) and those without a Thermal Store. A significant benefit of Stored FGHR systems is that they force the boiler to condense 100% of the time thereby improving efficiency, standard FGHR devices have no effect on whether a boiler condenses.

Due to the performance efficiencies offered by the patented Thermal Store, Stored FGHR systems including the GasSaver™ offer x10 the annual utility bill cost savings than standard FGHR systems. For a household this equates to saving of £100 to £200 per annum dependent upon the size of the dwelling and exact usage characteristics.

Stored FGHR (including the Canetis GasSaver™) are now recognised in UK SAP and provide substantial SAP score savings for developers of new properties. Depending upon the exact construction of a house and its location SAP score reductions of up to 24% can be achieved by incorporating a GasSaver™ in the design. The economics of this are that a house builder or developer can reduce build costs by an estimated £3k to £10k per property.

Following discussions with the relevant agencies Canetis understands that RdSAP now includes GasSaver™, this increases the total UK boiler market coverage to 43% for both SAP and RdSAP assessments.

Boiler Plus announced by the UK Government in October 2017, and effective from April 2018, also mandates FGHR devices as one of the measures which must be included with every new combination boiler installed in the UK – GasSaver fully meets this regulatory requirement.

Carbon Dioxide (CO²) savings available from Stored FGHR devices are also significant due to the energy efficiency that these devices provide, it is estimated that the UK would achieve 28% of the required CO² reductions needed by 2030 if a Stored FGHR device was included with every new combination boiler sold in the UK moving forward.

Water savings are also available to users of Stored FGHR devices through the reduction in wasted lukewarm water, this saving reduces water utility bill costs for those households on a water meter and is estimated to save 24m³ of water per household per annum. Across the UK this has the potential to save 350 billion litres of water, 12.3 TWh of gas (saving 2,600 KtCO₂e) and 300 GWh of electricity associated with the treatment and provision of drinking water to households – this has an equivalent power saving of the electricity required to typically run 86 thousand households for one year.

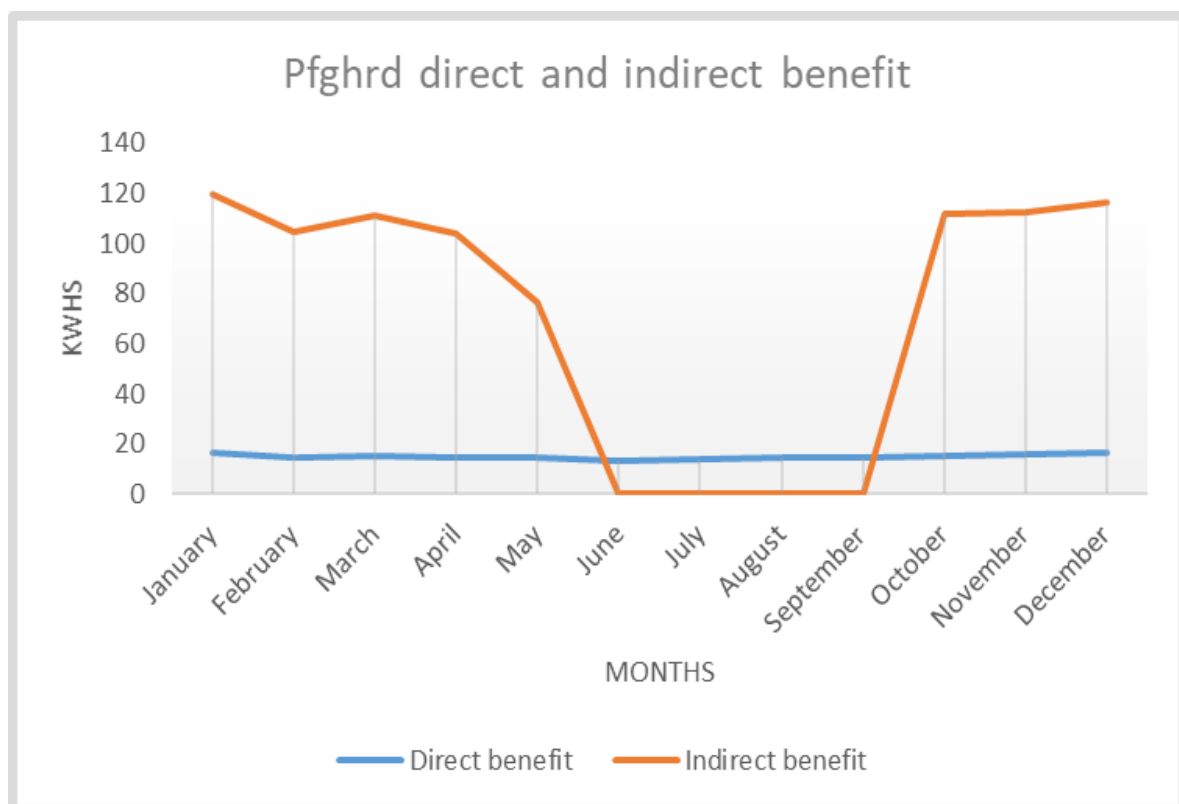
Finally, a significant green benefit to both users and the UK economy is that the installation of a Stored FGHR system has the effect of making a condensing boiler condensing for 100% of its operational time. This fixes a problem, and unintended consequence, that has existed since 2005 when condensing boilers were first mandated, it is estimated, that condensing boilers in normal use only condense for approximately 10% of the time when in space heating mode and it is a fact that they do not condense at all when producing DHW.

Introduction

GasSaver™ is a patented solution that delivers a **Flue Gas Heat Recovery (FGHR)** system with a **Thermal Store** a.k.a. Stored FGHR.

The GasSaver™ captures and reuses waste heat that ordinary condensing boilers discharge into the atmosphere via the flue (visible as excessive 'pluming'). Because of a presence of the Thermal Store GasSaver™ recovers heat from the boiler flue both during DHW production (referred to as a **direct benefit**) and during the space heating operation of a boiler (referred to as an **indirect benefit**).

The graph below shows both the direct and indirect benefits of GasSaver™ in terms of the heat recovered in KWHs across the months of a year. Understandably the indirect benefits are greatest in the winter and shoulder months (Spring & Autumn) when the boiler is being used to heat the property.



The total energy recovered by the GasSaver is the sum of both the direct and indirect benefits provided by the device.

Performance improvements for DHW production have been calculated as an efficiency gain of 51.4% saving the consumer money & reducing carbon emissions for both the household and UK Plc.

This equates to domestic utility bill savings of £100 to £200 per annum representing a payback of under three years at current GasSaver™ RRP, it is anticipated that this payback will reduce to approximately one year as demand for Stored FGHR systems increases and the associated supply curve shifts because of production scale.

FGHR systems have recently been recognised in impending regulation, UK Boiler Plus, which comes into force from April 2018. FGHR is included within the compulsory measures, one of which must be installed with every new combination boiler installed in the UK from April 2018. Unfortunately, Boiler Plus does not recognise Stored FGHR systems as being significantly more efficient than standard FGHR devices – this has the potential of delivering unintended consequences for the outcome of Boiler Plus with consumers potentially investing in inferior technology which does not provide the savings or payback available from Stored FGHR systems.

Fortunately, Stored FGHR systems are accurately accounted for in UK SAP, the Standard Assessment Procedure used to calculate the energy efficiency profile of all new build housing in the UK. This is because SAP is based on empirical test data provided by independent test agencies. Within SAP GasSaver™ can reduce Dwelling Emissions Rate (DER) scores by up to 24% providing significant cost benefits to builders and constructors alike.

How GasSaver™ Works

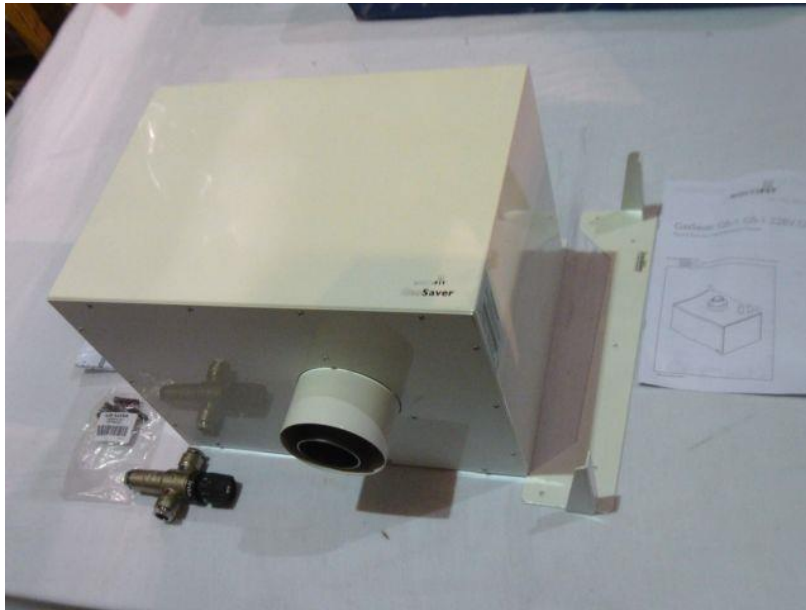
GasSaver attaches to the flue of a domestic boiler, the exhaust flue gases from the boiler pass through the GasSaver™, in doing so condense and are collected within the GasSaver™. This collection of condensate provides a Thermal Store from which energy can be recovered for use at a later point. The act of collecting the condensate has the effect of forcing the boiler to condense and therein finally delivers on the promise made to consumers by the manufacturers of condensing boilers however to this point undelivered due to a combination of technical limitations and the everyday usage patterns.

The recovered energy is then mainly used to pre-heat the DHW cold water feed for both combination boilers and system boilers.

Analysis of SAP scores for Stored FGHR systems outlines a recognition of the influence of indirect benefits on improved seasonal efficiency of gas boilers, in summary -

- GasSaver™ achieves 51.4% efficiency gain in DHW production based on:
 - 8.2% avg direct savings, relating to EN13203/2
 - 43.2% avg indirect savings, equals 5.87%² improved seasonal efficiency of space heating.

The following diagram shows a GasSaver™ pre-installation, the GasSaver™ chassis, mounting bracket and blending valve are clearly visible. Post installation the GasSaver™ requires no consumer interaction by way of user controls, Stored FGHR systems are passive devices that work automatically when the boiler is in operation. Finally, there is no maintenance post installation and the GasSaver™ has the same life expectancy as the boiler it is installed with.



Space Heating vs Domestic Hot Water

Powering a GasSaver™ from the waste flue gases is an efficient and effective approach given typical domestic heating and DHW usage patterns as outlined below.

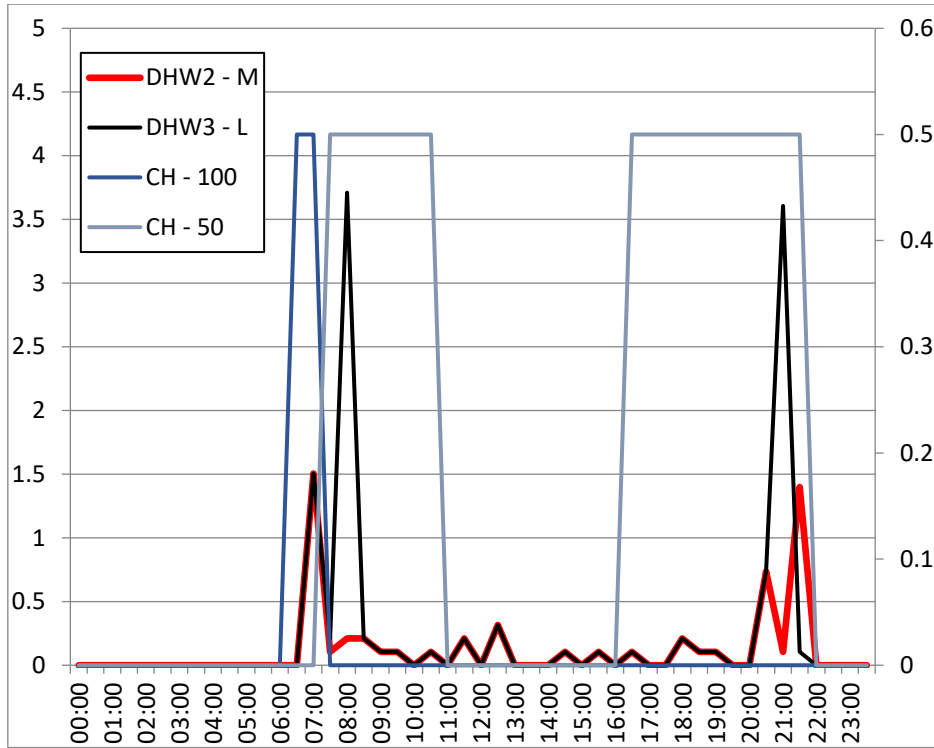
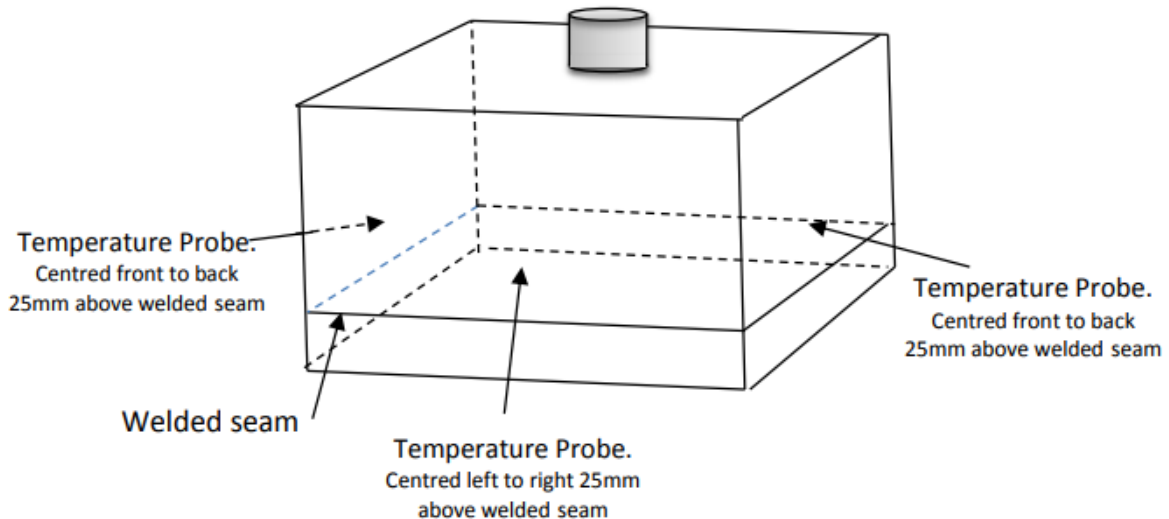


Fig 2 - Typical UK heating and hot water interaction

The above chart shows the typical interaction between heating and DHW for a UK home and whilst other EU countries may have different heating and hot water temperature ranges, most do operate around a Monday through Friday work day. More than 90% of total DHW demand occurs when the boiler is already in operation for domestic heating making it possible for the GasSaver™ to recover additional heat from the exhaust gases in the boilers flue.

GasSaver™ Technical Overview

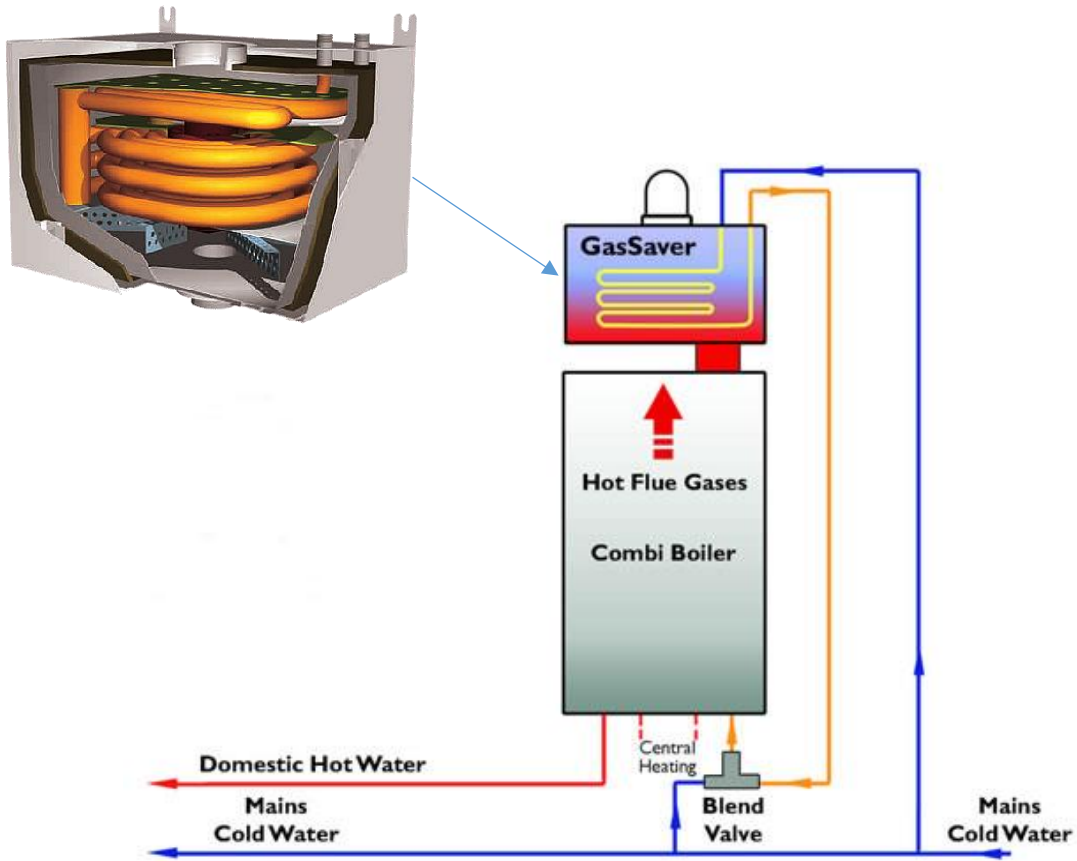
The main components of a GasSaver™ can be seen in the diagram below.



The following shows the typical deployment of a GasSaver™ in conjunction with a combination boiler.

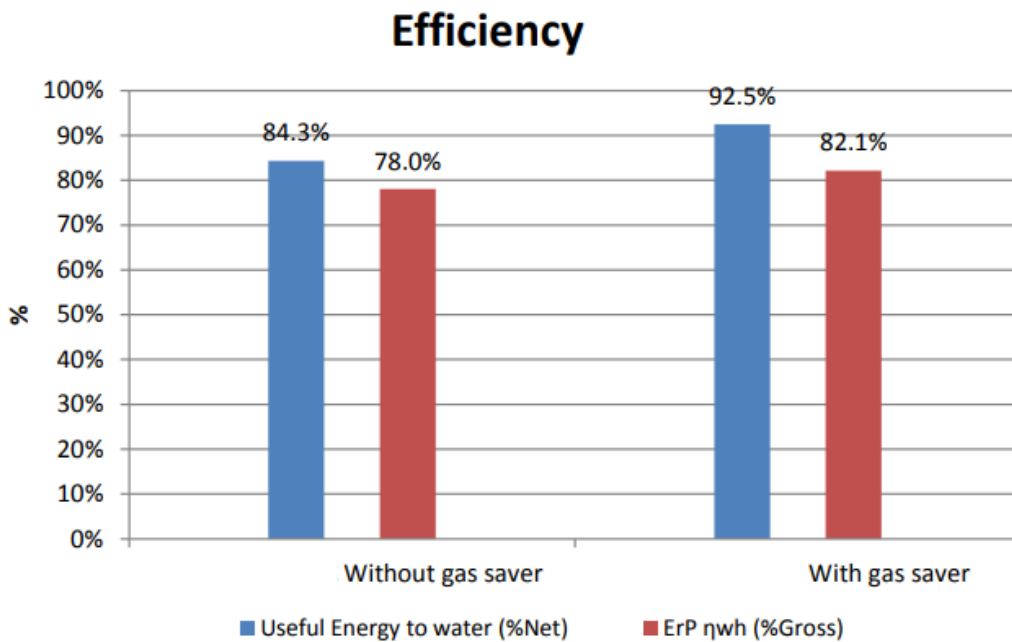
The mains cold water feed is connected to the GasSaver™ allowing cold water to pass through the GasSaver™ via the coil within the device. The coil is submerged in the collected condensate (Thermal Store) with the effect of pre-heating the cold water prior to it entering the boiler. A blending valve is also used to ensure that the water entering the boiler does not exceed 30°C thereby potentially causing the boiler the shutdown or enter a reset mode.

Based on significant testing 30°C is the optimal temperature at which to introduce water into most combination boilers.

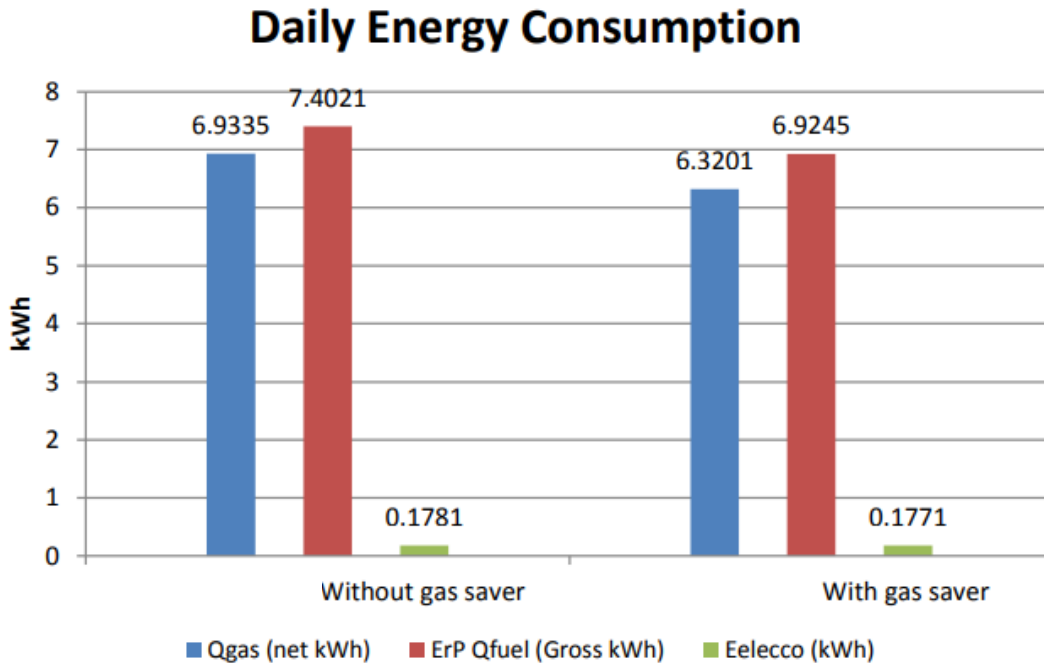


GasSaver™ Test Data

Based on independent tests the following efficiency results have been measured for a 30KW boiler both with and without a GasSaver™

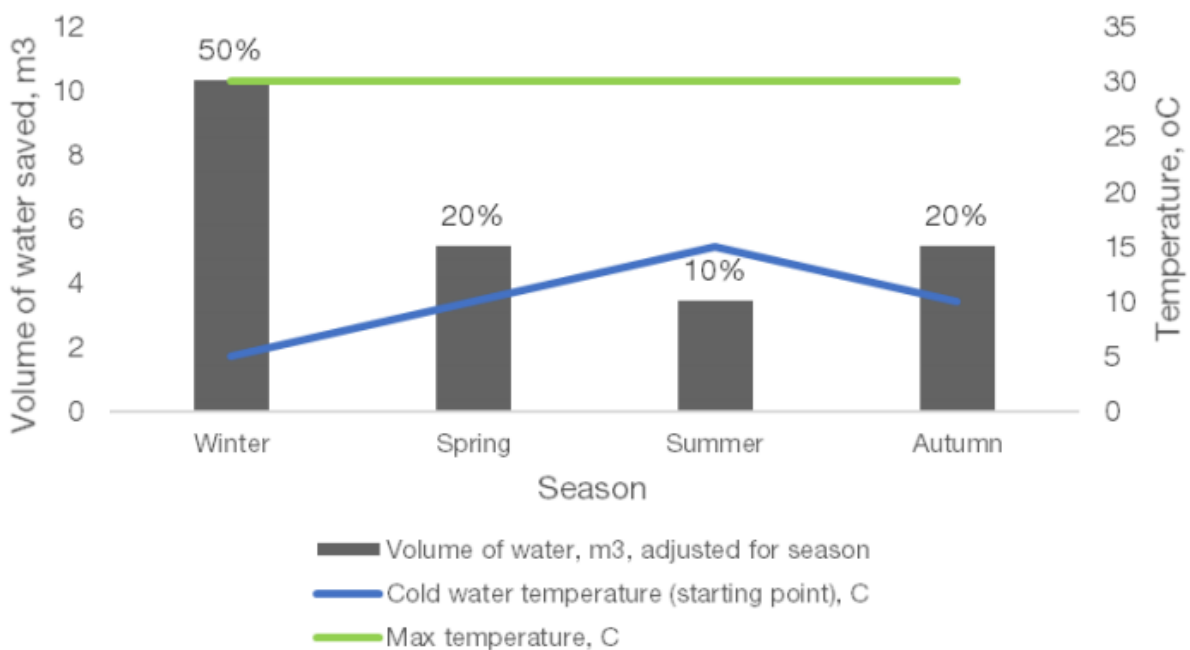


Daily efficiency for the same boiler is as follows -



GasSaver™ Water Savings

Stored FGHR systems reduce waste water by reducing the amount of lukewarm water that is rejected when a combination boiler is initially turned on to produce DHW. Quite simply because warmer water is input to the boiler (the water having already been partly heated by the GasSaver™) this results in the boiler achieving its required level of performance faster with less partially heated (lukewarm) water being wasted.



The above graph contains independently produced data and shows the benefit in terms of the amount of lukewarm water saved using a GasSaver™ throughout a typical year.

Water utility cost savings to consumers from the water saved varies dependent upon which water authority a consumer supplies the consumer. The table below shows a range of available savings for an average UK household dependent on the Water Authority involved.

	<i>Water and sewerage (metered) price, £/m³</i>	<i>Bill savings per year</i>
Anglian Water	3.1967	£77
Welsh Water	2.9942	£72
Northumbrian Water	2.3744	£57
Severn Trent Water	2.3475	£57
Southern Water	3.5870	£86
South West Water	5.4879	£132
Thames Water	2.0780	£50
United Utilities	2.9720	£72
Wessex Water	4.0169	£97
Yorkshire Water	2.8993	£70
Northern Ireland Water	2.7400	£66

When considering these water savings from the point of view of UK Plc. these savings are material. Fresh water is already an increasingly scarce (especially during the summer months) and expensive resource and this problem is only set to increase with the increasing size of the population together with climate change.

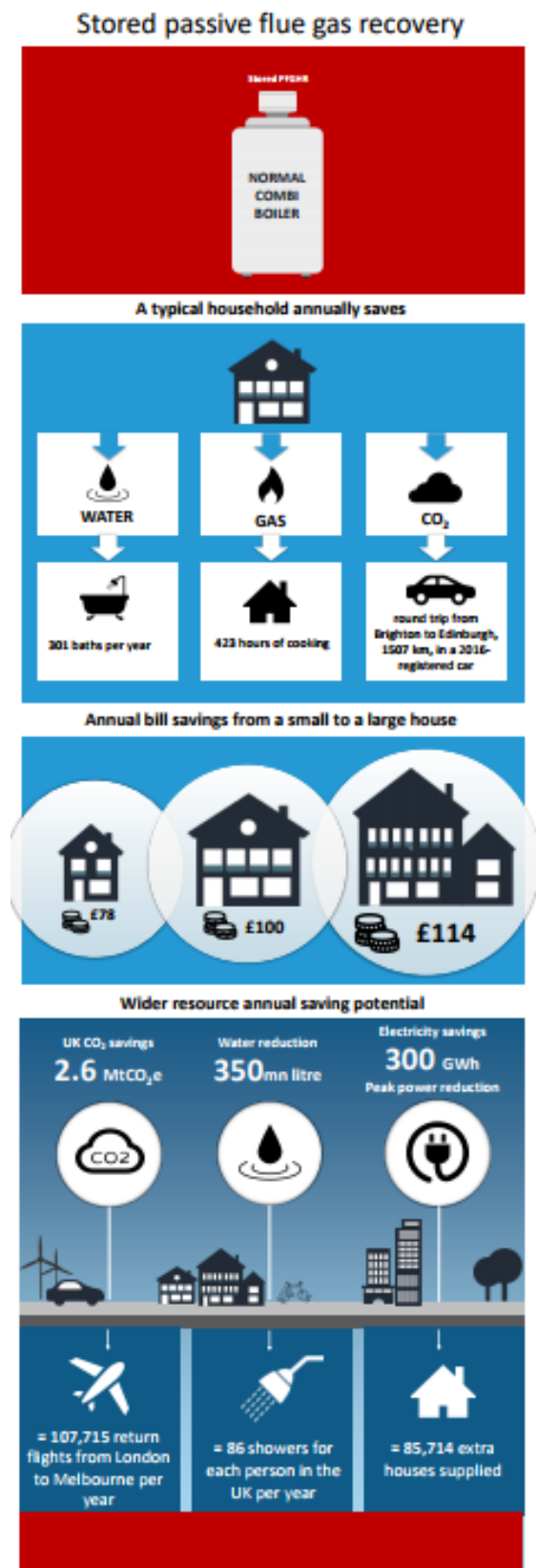
The table below shows the aggregate costs of rolling out Stored FGHR systems in the UK and the benefits that this would provide to UK Plc. in terms of costs savings to consumers, water consumption reduction, gas savings, CO₂ reductions for both the consumer and water industry and also the total electricity saving available to water suppliers due to the reduction in the quantity of water supplied.

	Number of combination boilers	14.5 million
	Aggregate cost of stored PFGHR installation	£6.7 billion
Customers	Aggregate customer bill savings per year	£1.45 billion
	Water savings per year	350 billion litres
	Gas savings per year	12.3 TWh
	CO₂e savings per year	2,266 KtCO ₂ e
Water industry	Electricity savings per year	300 GWh
	CO₂e savings per year	368 KtCO ₂ e

GasSaver™ Features & Benefits

The key features & benefits of GasSaver™ are:

- Regulation
 - Reduced SAP scores – DER can be materially reduced in new build when a GasSaver™ is installed.
 - Boiler Plus – mandates FGHR as a required measure from April 2018, GasSaver fully meets, and materially exceeds, the threshold of this new regulatory requirement.
- Improved Efficiency
 - Reduced gas consumption and costs – by recovering waste heat from the boiler flue the GasSaver™ saves gas.
 - A key benefit of GasSaver™ is that it reduces the amount of wasted lukewarm water that a boiler produces. A boiler fitted with a GasSaver™ produces useful hot water faster, which means households see a drop in their water consumption and water bills.
 - GasSaver™ benefits are at their optimum in winter months when savings are most needed. As a gas boiler consumes more gas, then GasSaver™ recovers more wasted energy, which significantly reduces CO₂ emissions and cuts fuel bills.
 - Lower CO₂ emissions.
- Comfort
 - Provides faster hot water delivery around the home
- Savings
 - GasSaver™ is a low cost solution providing an ROI in under 3 years from lower utility bills.



- Zero lifetime maintenance & cost post installation
- Requires no mains electricity
- General
 - Easy installation by a qualified GasSafe fitter
 - Suitable for new build, boiler replacement or retro-fit
 - No user intervention required, **“it just works”**

Overall GasSaver™ is one of the most practical and sensible ways for homeowners, and fuel bill payers, to become energy efficient and save money.

And finally - GasSaver™ is manufactured to the highest quality standards, is approved under the Water Regulations Advisory Scheme (WRAS), and is recommended by the Energy Savings Trust.

GasSaver™ Deployment

Existing Combi-Boiler Retrofit & Replacements

Stored FGHR systems can be installed as a retrofit to an existing boiler installation; as part of a boiler replacement activity when a boiler reaches end of life or when a property is refurbished. All of these activities require the use of a trained installer due to complexities relating to the boiler flue location and the installation of a GasSaver™ is not a job that can reasonably be undertaken by the average DIY enthusiast.

New Builds

New developments represent an excellent opportunity to implement a GasSaver™, at this time the location of the boiler and GasSaver™ can easily be planned and the incremental effort required to installed a GasSaver™ is almost negligible when compared to the effort required to install a boiler and associated central heating and DHW systems.

Regulation Changes

The UK Government is now embarking on a new era of heating and hot water efficiency with the announcement of Boiler Plus. Commencing in early Q2 2018, Boiler Plus sets new mandated efficiency standards for boiler installations across both new build and the replacement market. Additionally, Minimum Energy Efficiency Standards (MEES) relating to landlord responsibilities for the minimum efficiency of residential let property captures both private and social housing within the scope of this policy.

UK Boiler Plus & GasSaver™

Specifically, Boiler Plus requires that every new boiler installed must include one of four efficiency options. These options are further outlined in the tables below including a high-level SAP analysis

Option 1 - Flue Gas Heat Recovery (FGHR)				
<i>Product</i>	<i>Cost</i>	<i>SAP DER Benefit</i>	<i>Total SAP Benefit</i>	<i>Comments</i>
GasSaver™	£400 - £500	17%	17%	DER benefit & consumer saving of £100 to £200 per annum
Option 2 - Weather Compensation				
<i>Product</i>	<i>Cost</i>	<i>SAP DER Benefit</i>	<i>Total SAP Benefit</i>	<i>Comments</i>
Weather Comp	£50 - £100	1.7%	1.7%	No real payback
Option 3 - Load Compensation				
<i>Product</i>	<i>Cost</i>	<i>SAP DER Benefit</i>	<i>Total SAP Benefit</i>	<i>Comments</i>
Load Comp	£100 - £250	0.5%	0.5%	No real payback
Option 4 - Smart Controls				
<i>Product</i>	<i>Cost</i>	<i>SAP DER Benefit</i>	<i>Total SAP Benefit</i>	<i>Comments</i>
Smart Home System	£250 - £1000	0.5%	0.5%	No real payback

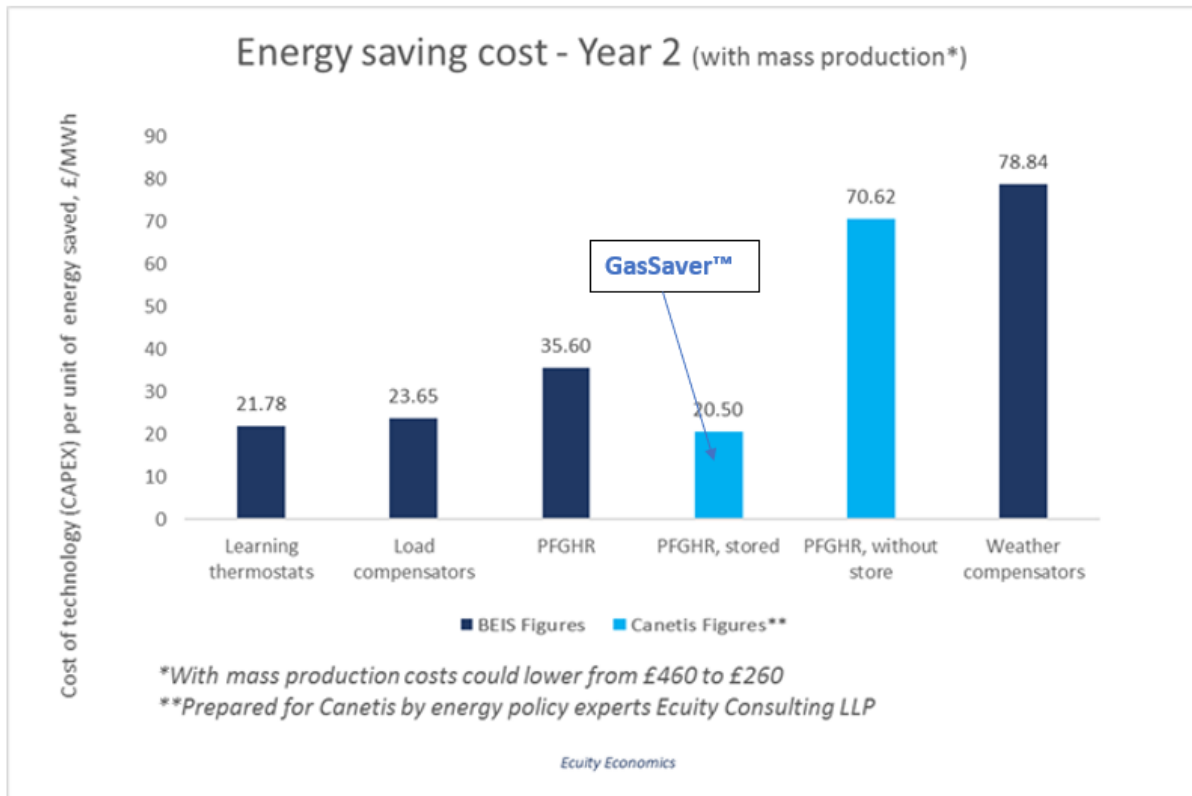
N.B. Dwelling Emission Rate (DER) SAP savings are normally cumulative and % savings are house type dependent.

What the analysis clearly shows is that GasSaver™ has the greatest impact on reducing SAP DER scores of any Boiler Plus measure. For a new build project this can translate into cost savings of many thousands of pounds – these cost savings are estimated to be between £3k and £10k per new build house.

[More on UK Boiler Plus](#)

Weather Compensation, Load Compensation and Smart Home Systems are already identified by the Government as life style products that only offer energy savings when consumers are engaged in their operation. However, GasSaver™ is recognised for its improved energy efficiency as it is a passive device requiring no user intervention.

The following graph, prepared by Ecuity Economics on behalf of Canetis, provides an analysis of the Energy Saving Costs across all Boiler Plus measures. It is clear to see the difference between Stored FGHR systems (GasSaver™) and standard FGHR devices. Also it is clear to see that GasSaver™ provides the best Energy Saving Cost measure of any of the Boiler Plus measure at just £20.50 /MWh of energy saved.



UK SAP Analysis & Costs Savings

Fig 5 below highlights SAP benefits for GasSaver™ in SAP for various house types. Savings vary depending on many factors including post code, orientation and method of construction. Typically, GasSaver™ scores highest for smaller new build homes whilst a GasSaver™ & SuperFlow™ combination scores best for larger multi-bathroom properties.

Reducing SAP Scores For New Build Houses



- This chart shows the relative SAP scores for various houses and respective heating solutions with Canetis GasSaver clearly providing improved DER outputs from the SAP model

House Type	Model	DER	TER	%
4 Bed Detached	Alpha Intec 30SE w/ 200L Unvented Cylinder	18.11	18.85	3.90
	Alpha Intec 40 + GasSaver & Superflow	16.32	18.85	13.44
3 Bed Semi	Alpha Intec 30C	17.34	18.18	3.85
	Alpha Intec 30 + GasSaver	14.29	18.18	21.40
3 Bed End Terrace	Alpha Intec 28XE	20.07	20.29	1.10
	Alpha Intec 40 + GasSaver & Superflow	15.86	20.29	21.83
Add 12Volt SuperFlow Solar PV top-up for an additional 1.5% benefit				

% DER improvement over TER compared to a standard condensing gas boiler

DER & TER numbers automatically generated by the SAP model from input data relating to method of construction and products used

- Reduced DER results in **£3k to £10k** cost savings per property developed.

Worked SAP calculation benefits for GasSaver™ & SuperFlow™ solutions.

RdSAP Return On Investment

Canetis understands that GasSaver is now available within RdSAP assessments, the following table, which is based on a three-bedroom semi-detached house, outlines the likely benefits when compared to other energy saving measures available to consumers within the RdSAP methodology –

No.	Measure	Indicative Cost (£)		Annual Savings (£)	ROI (Years)		Cost of Saving (£/£/year1)	
		Low	High		Low	High	Low	High
1	GasSaver™	£200	£450	£100	2.0	4.5	£2.00	£4.50
2	Loft Insulation	£100	£350	£70	1.4	5.0	£1.43	£5.00
3	Draught Proofing	£80	£120	£12	6.7	10.0	£6.67	£10.00
4	Solar PV (2.5kWp)	£5,000	£8,000	£300	16.7	26.7	£16.67	£26.67
5	Floor Insulation Internal or External	£800	£1,200	£36	22.2	33.3	£22.22	£33.33
6	Wall Insulation Double Glazed	£4,000	£14,000	£308	13.0	45.5	£12.99	£45.45
7	Windows	£3,300	£6,500	£46	71.7	141.3	£71.74	£141.30
8	Solar Water Heating	£4,000	£6,000	£35	114.3	171.4	£114.29	£171.43

Clearly GasSaver™ can be seen vying for the ROI top spot with Loft Insulation a recognised energy saving measure. Surely now is the time for the UK to also recognise the benefits of GasSaver™ and promote the deployment and wide scale use of Stored FGHR systems?

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