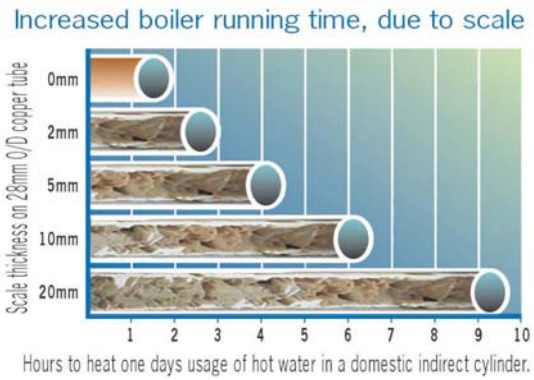
Energy & Environmental Issues Regarding Hard Water

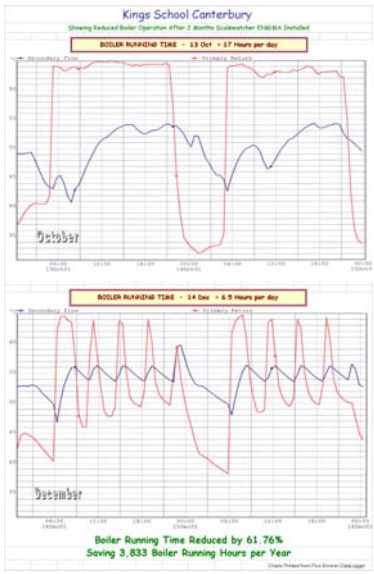
Hard water. Water that is naturally hard, as in 70% of the UK contains dissolved calcium and other minerals. These help to build and maintain healthy bodies, but their effect on pipework and water systems can be disastrous. When water-borne minerals, such as calcium bicarbonate, revert to their solid carbonate state, limescale is formed in water systems, and this narrows pipes, blocks jets, slows the flow, reduces thermal efficiency and provides a breeding ground for bacteria.

Research has shown that just 6 mm of limescale will reduce energy efficiency by a staggering 40%, and, in a moderately hard water area, 6 mm of limescale can form in pipework, or on heat exchangers in just 2 years. This in turn results in higher running costs. Billions of pounds are wasted every year in increased energy bills, lost production and early renewal of capital equipment.



Portsmouth University used the difference in thermal transfer properties of copper pipe and hard water scale to calculate how long the water needs of a family would take to heat in a conventional domestic hot water cylinder.

The conclusions are shown on the adjacent graph. With no scale on its heat exchanger, it takes 1½ hours to heat up. However, with just 5mm of scale the boiler now has to run for over 4 hours, 2½ hours longer. This is because the thermal conductivity of calcium carbonate (scale) is 4,000 times less than that of copper



The larger the water system, the greater the potential energy wastage. At King's School Canterbury a temperature data-logger and an electronic descaler was placed on two parallel hot water calorifiers, heating a total of 9,000 litres of water.

The data-logger outputs show that on the installation date, the primary boiler was running continuously for 17 hours during the day, attempting to get the water to the required temperature. Two months later, when the heat exchanger had began descaling, the boiler ran just 6½ hours, a reduction of almost 62%. Looked at another way, pre-installation it took 6 hours and 20 minutes for water temperature to recover 10ºC and once the heat exchanger became more efficient, by removing scale, recovery time dropped to 2 hours 40 minutes.

Energy is wasted due to scaling in many ways. About the most wasteful are air-conditioning and refrigeration chillers. One major chiller manufacturer, York International, admits that just 0.04 of an inch of scale on condenser tubes of a typical 500 ton chiller, wastes £25,000 in energy per year. These tubes are typically ¾ inch diameter and are often found completely blocked with calcium in under a year, so 0.04inch of scale can be formed very quickly!

Very little research has been carried out to investigate scale as a source of energy wastage. British Gas did so in the early 1990's but the report has never been made public. A recent report carried out by Advantica, at the former British Gas Research Establishment in Loughborough, measured the relative energy consumption of a clean and scaled gas fired water heater. This report concluded:

> In the 'steady state' fully-fired condition the 9 grams of scale deposited in the heat exchanger resulted in an average reduction of 5.6% in gas boiler efficiency. In 'heat-up' mode (as with an instantaneous water heater, i.e. turning the gas fully on and measuring the time taken in the test to heat the water by 43°C) the 9 grams of scale deposited in the heat exchanger resulted in an average reduction of 17% in gas boiler efficiency.
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> Implications for High Efficiency Condensing (SEDBUK A or B Rated) Boilers Now Required Under Part L of the Building Regulations and Carbon Dioxide Emissions For an average system with 100 litres of water in the primary circuit in a hard water area i.e. >200 mg/l total hardness (representing an estimated 65% of the UK population) assuming only half of the potential 20g of scale is precipitated in the heat exchanger; the efficiency of typical SEDBUK A boiler will be reduced to that of a boiler with SEDBUK C rating within the first few heating cycles.
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> Using figures from DEFRA that a 3% reduction in average boiler efficiency equates to an increase of 160 kilograms of CO2 (carbon dioxide) emissions per annum, this represents an increase of at least 298 kilograms in CO2 emissions from 65% of the estimated 17 million gas-fired boilers in the UK, i.e. equal to a combined total in excess of 3.25 million tonnes of CO2 emissions per annum.

Currently no Government Agency (Carbon Trust, EST, BRE, etc) recognise the potential energy (and water) savings to be made by encouraging the use of water treatment in hard water areas, (70% of the UK). With new and emerging technologies, it is no longer necessary to resort to chemical methods. Therefore there is no longer any reason to discourage water treatment as a means of saving energy and preventing damage to appliances and water-fed equipment. This provides a great opportunity for the E.I.C. to be in the forefront of a campaign to increase awareness and to lobby for inclusion in both Part L of the Building Regulations, the Home Information Pack and the forthcoming Sustainability Buildings Codes.