A brief evaluation of water repellent surface protection for masonry, and potential energy requirements in space heating

Giraffe Innovation

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SUMMARY REPORT

Executive Summary

This co-funded study by MAS South East and Safeguard Europe consists of a) peer review of selected literature, b) update of previous SAP CO_2 figures for a typical house model with solid brick walls, c) a carbon footprint assessment[1] of *Stormdry* (a breathable waterproofing cream for bricks and mortar) and d) an estimate of carbon savings from lower space heating requirements due to the surface treatment. The key findings from this study are:

- The updated SAP figures for space heating are around 5,209 kg CO_2 per year for an untreated house model, and 3,798 kg CO_2 for a surface treated one under extreme weather conditions, i.e. a carbon reduction of **27%** (excluding additional benefits from reduced evaporated cooling).
- The carbon footprint of a *Stormdry* application is **0.73 kg CO_2e/m^2** (i.e. less than 1% of a UK person's carbon footprint).
- Annual carbon savings from reduced space heating range between **635 and 1,991 kg CO_2e** depending on weather conditions. Over a product lifetime of 20-30 years, the treatment can potentially save between **24,081 and 36,817 kg CO_2e** compared to an untreated solid brick house, provided there is no change in consumer behaviour.
- On average, the "carbon payback" for the *Stormdry* treatment due to savings in space heating is one month; the monetary investment is recovered after 6 years.
- This work will enable Safeguard to promote their product with robust environmental evidence.

[1] The carbon footprint, expressed in kg of carbon dioxide equivalents, is another name for global warming potential. It measures the effect on climate change over 100 years (standard assessment method by the Intergovernmental Panel on Climate Change).

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1. Introduction

Safeguard Europe Ltd. is a UK-based company specialising in providing damp- and water-proofing solutions for the construction industry. Safeguard was established in 1983 to produce products for the refurbishment of existing buildings.

Co- funded by MAS South East, this project will assess the Safeguard´s *Stormdry* product, a breathable waterproofing cream for bricks and mortar. Previous research has identified that the coating saves energy by reducing both thermal conductivity and the evaporative cooling of bricks, which in turn can reduce energy requirements for domestic space heating. The project included a peer-review of selected literature from previous research on this and a similar product, followed by a high-level carbon footprint assessment of a *Stormdry* treatment, and potential carbon reductions from reduced space heating for a typical house model with solid brick walls and 108m^2 wall area. This report summarises the project´s key findings.

2. Project scope

1. Peer review of the following reports and research papers:
    a. Safeguard Laboratory report no.5 – Feasibility study on heat loss savings from the treatment of masonry with water repellents.
    b. Safeguard Laboratory report no. 18 - Estimates of energy savings with *Stormdry.*
    c. Safeguard Laboratory report no. 42 – Green deal – call for evidence.
    d. Vemund Årskog, Sverre Fossdal, Odd E. Gjørv (2003): Methodology and data for calculation of LCE (Life Cycle Ecology) in repair planning. RDT Project: Life Cycle Management of Concrete Infrastructures for Improved Sustainability: LIFECON (funded by the European Community under the Competitive and Sustainable Growth Programme 1998-2002).

e. James MacMullen, Zhongyi Zhang, Eric Rirsch, Hom Nath Dhakal, Nick Bennett. Brick and Mortar Treatment by Cream Emulsion for Improved Water Repellence and Thermal Insulation. Building and Environment, 2011, 43, 1560-1565.
f. Other research commissioned on behalf of Safeguard.

2. Aggregated carbon footprint analysis taking a life cycle approach (cradle to grave) for the *Stormdry* barrier cream.
3. Update the previous SAP carbon emission factors for gas and electricity and recalculate the carbon emissions for the two house models.
4. Assessment potential carbon savings /payback through use of a water repellent product such as *Stormdry*.

3. Peer review

A variety of waterproof coatings for construction materials are available on the market, and the link between treating masonry with water-repellents and thermal insulation seems to be well understood and established in the relevant academic literature. A peer review of selected literature was carried out by Giraffe on behalf of Safeguard. For further information please contact Dr Eric Rirsch (eric.rirsch@safeguardeurope.com).

4. Update of SAP carbon emission figures

The CO_2 emission rates from the SAP worksheet (Safeguard laboratory report no. 18) have been updated using the latest (2011) Defra emission factors for gas and electricity. The results reflect the 23% saving in total carbon emissions, and the 27% in space heating (i.e. attributable to surface treatment):

SAP laboratory report – update	**Untreated kg CO_2**	**Treated kg CO_2**	**Reduction**
Space heating (box 101)	5,208.96	3,798.30	-27%
Water heating (box 103)	652.18	652.18	
Space and water heating (box 107)	5,861.14	4,450.48	
Electricity for pumps and fans (box 108)	91.20	91.20	
Energy for lighting (box 109)	277.38	277.38	
Total kg CO_2/year (box 112)	**6,229.72**	**4,819.06**	-23%
CO_2 emission rate per m^2 (box 113)	**84.64**	**65.47**	-23%

5. Carbon Footprint of hydrophobic surface application (Stormdry)

5.1. Methodology and assumptions

The carbon footprint assessment of a "Stormdry" application was based on the following methodology and assumptions:

- Information provided by Safeguard on
  - Gas and electricity consumption in manufacture
  - Supply chain and UK distribution logistics
  - Aggregate product formulation
  - Packaging
- Target coverage of 200ml/m^2 (http://www.stormdry.com/application/), presumably with brush or roller (equivalent to 0.17 kg per m^2).
- Hot water surface cleaning of masonry; CO_2e value from Årskog et al (2003) for a silane-based, hydrophobic surface treatment. (Note that there are other cleaning methods).
- Total life cycle taken into account – from raw material production to disposal - for all key materials including packaging (scope outlined in Figure 1).
- Modelling of Silanes and Siloxanes to approximate environmental impact based mainly on Ecoinvent database in Sima Pro (using data from major European producers) and adjusted with Safeguard information; similar to Årskog et al. (2003) the results for this compound are likely to be underestimated due to producer confidentiality issues.
- Results expressed in kg of carbon dioxide equivalents (kg CO_2e) per m^2 treated wall surface.

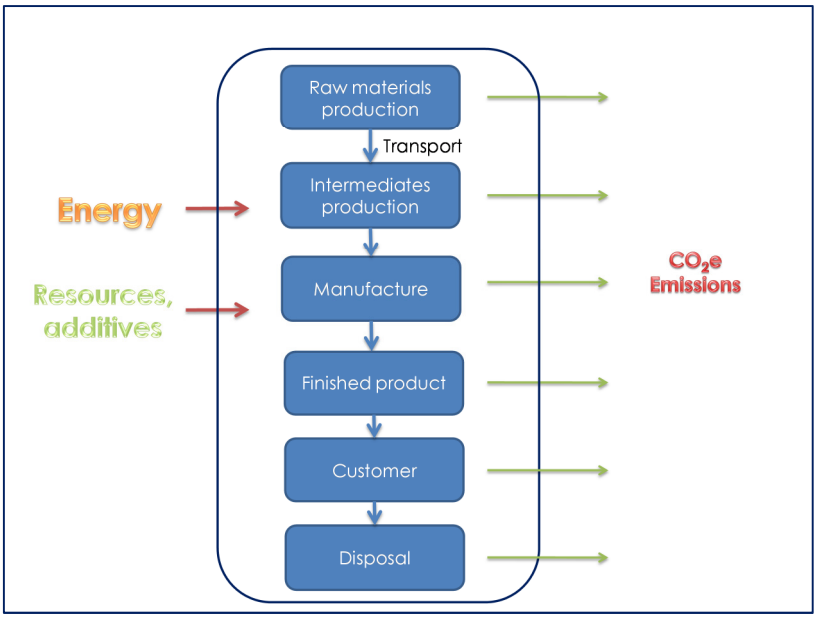

Figure 1. Scope of assessment for *Stormdry* application

5.2. Results

Per m^2 of treated masonry surface, the carbon footprint results in 0.73 kg CO_2e or 79 kg CO_2e to treat 108 m^2 for a typical solid wall semi-detached house. Having modelled pallet and cardboard-box delivery, the difference in carbon footprint is negligible (0.74 kg CO_2e/m^2 for the box-based delivery scheme).

In general, gas consumption and production of methyl chloride are the most energy intensive processes for silicone products[2].The largest contributors to the carbon footprint of *Stormdry* are gas and electricity consumption in manufacture at Safeguard (42%), the silane/siloxane production itself (25%), and delivery within the UK by van (10%). Other formulation ingredients, packaging, supply chain transport, disposal, supply chain transport and surface cleaning contribute less than 10% to the carbon footprint (Figure 2).

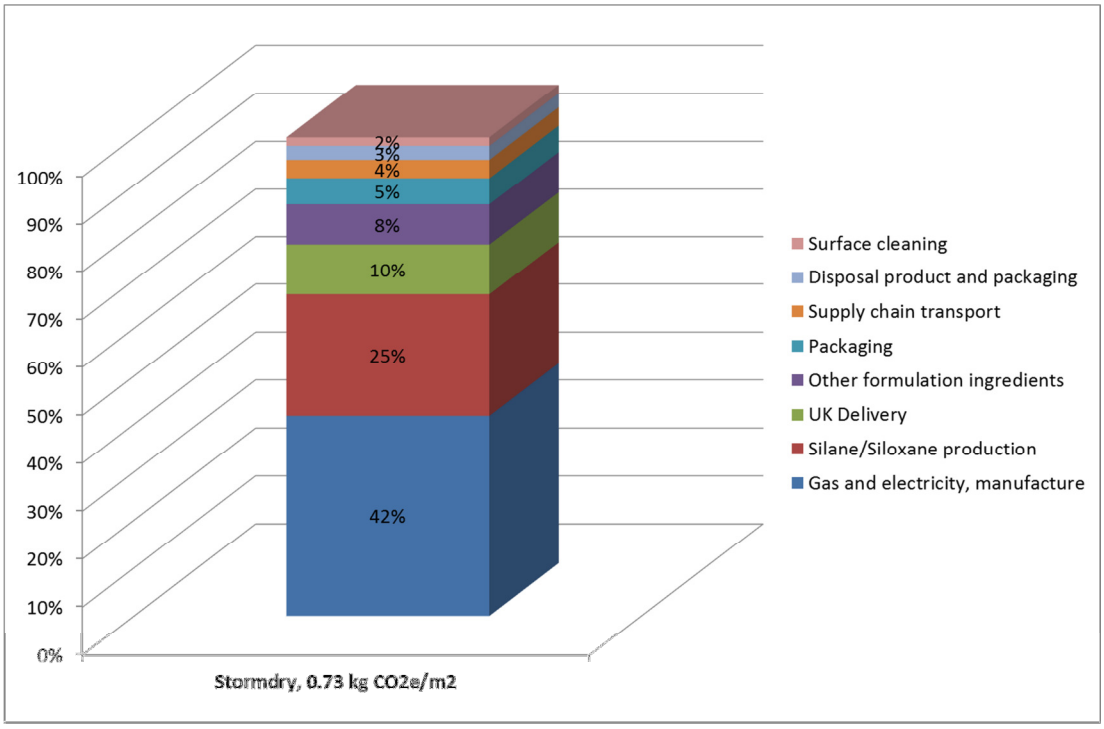

Figure 2. Carbon footprint per m^2 of *Stormdry* application

5.2.1. Context with other materials and activities

To put this result into perspective, *Stormdry´*s carbon footprint of 0.73 kg CO_2e per m^2 compares to around 1.05 kg CO_2e per m^2 of Rockwool insulation (100mm thickness), 13.7 kg CO_2e per m^2 of PU foam, 11.2 kg CO_2e per m^2 of EPS slab, 1.3 kg CO_2e per 800g loaf of bread – or driving a small petrol car 2.4 miles. The carbon footprint of treating a typical solid wall brick house with *Stormdry* is less than 1% of the average carbon footprint for a UK citizen.

[2] Ecoinvent (2007). Lifecycle Inventories of Chemicals. Dübendorf, Switzerland.

6. Potential savings in space heating

To make the SAP results from section 4 comparable with the *Stormdry* carbon assessment, the updated SAP carbon dioxide figures (CO_2) have to be converted into carbon dioxide equivalents (CO_2e).

Compared to an untreated house the potential annual carbon savings are around 1,912 kg CO_2e under extreme weather conditions and 635 kg CO_2e under drier conditions[3] (provided there is no change in consumer behaviour such as turning up the heating). On average, the initial "carbon investment" for the surface treatment is recovered after just one month from savings in space heating.

Assumptions for "carbon payback"	**kg CO_2e (-27%)**	**kg CO_2e (-9%)**
Untreated house, space heating, per year[4]	7,060	7,060
Application of *Stormdry*	79	79
Total including application	7,139	7,139
Treated house, space heating, per year	5,148	6,424
Potential savings per year	**-1,912**	**-635**

The Stormdry surface protection will last between 20 and 30 years. (http://www.safeguardeurope.com/products/stormdry-masonry-protection.php). Over this time, assuming the average of dry and most extreme weather conditions, the surface treatment can potentially save between 24,081 and 36,817 kg CO_2e compared to an untreated solid brick house (Figure 3).

[3] Using the 9% figure from the SAP Laboratory report R&D 18
[4] Both values based on SAP Laboratory report R&D 18 for simplification

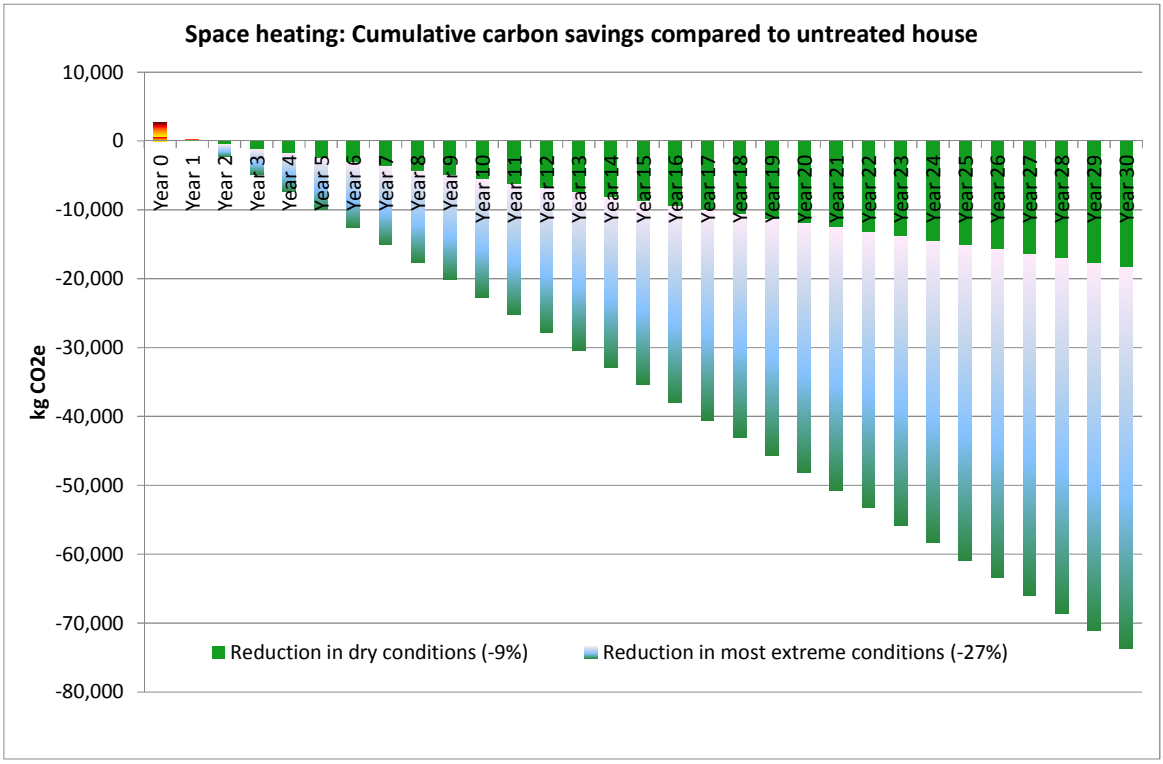

Figure 3. Potential carbon savings from surface treatment over time

Note that this is a simplification only; wet and dry conditions alone should not be used to estimate annual energy consumptions or carbon savings as they do not take into account actual geographic and weather conditions.

The carbon savings correspond with Safeguard's cost-benefit analysis showing a payback period of 6 years for a treatment including material and labour[5] (assuming application costs of £500 and £74 savings per year from reduced space heating based on the SAP assessment; Figure 4).

[5] Safeguard laboratory report no. 42

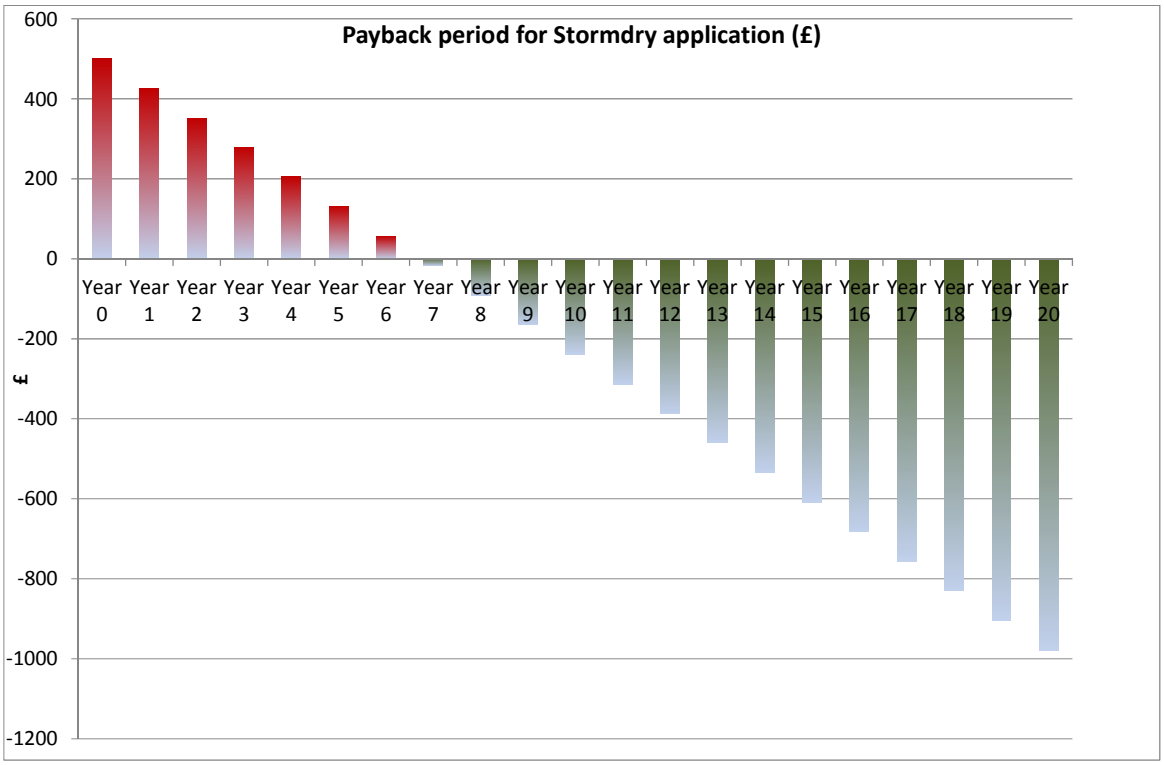

Figure 4. Payback period for *Stormdry* treatment including materials and labour