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## **JACKODUR PLUS AND THE GREEN GUIDE**

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# 1 INTRODUCTION

Jackon UK has been asked where one of its products - Jackodur Plus - would stand in the "Green Guide" rating scheme for construction products that is widely referenced by specifiers in the UK construction industry. The "Green Guide" scheme itself is now closed to new entrants, therefore Jackon UK cannot pursue a formal rating within the scheme. Jackon UK therefore asked EuGeos Limited, a consultant with extensive relevant experience, to provide guidance on this question.

This short report summarises that guidance, which is based on information provided by Jackon about Jackodur Plus and public-domain information about the environmental credentials of other XPS insulants. Some relevant background is provided first.

## 2 BACKGROUND

### 2.1 JACKODUR PLUS

Jackon UK supplies insulation produced by Jackon in Germany into the UK market; one of its products is Jackodur Plus. Jackodur Plus is an extruded polystyrene insulation with density in the range 30-50kg/m<sup>3</sup> and thermal insulation of 0.025 - 0.027W/mK<sup>1</sup>. Jackodur Plus is manufactured using a "hydro-fluoro-olefin" foam-blowing agent (HFO1234ze).

Potential users of Jackodur Plus are interested in its environmental credentials, as they are for alternative insulants and for construction materials in general.

### 2.2 ENVIRONMENTAL EVALUATION OF CONSTRUCTION PRODUCTS

The environmental credentials of construction products are commonly evaluated using the results of life cycle assessments (LCA). LCA provides a mechanism for investigating and evaluating the environmental impacts of products all the way from the extraction of basic materials from nature, through their conversion to product-specific raw materials and components, product assembly, distribution, use and end-of-life management (disposal, reuse, recycling &/or recovery).

LCA results for construction products are commonly presented in Environmental Product Declarations (EPD)<sup>2</sup>. In the UK, these results were also used to rank different construction products and building elements in the Building Research Establishment's "Green Guide to Specification" starting from 1996<sup>3</sup>. Green Guide ratings were allocated on a scale from A+ to E, and derived from LCA carried out using BRE's Environmental Profiles Methodology<sup>4</sup> which included a weighting scheme to allow performance ratings from several environmental schemes to be combined into the single overall A+ to E rating. Ratings were published for generic materials based on data from groups of manufacturers, while manufacturer-specific "Certified Environmental Profiles" were also published<sup>5</sup>.

The Environmental Profiles Methodology was last updated in 2008; it was largely superseded by a European standard for the production of EPD - EN15804 - published in 2013. EN 15804-compliant EPD are published by the BRE, by the German Institut Bauen und Umwelt e.V. (IBU), by the International EPD System, and others. EN 15804-compliant EPD cover a range of environmental themes that is different from those covered by BRE Environmental Profiles and do not include a weighted overall score.

Despite its near-obsolescence, Green Guide ratings are still widely-referenced in the UK construction sector, for two reasons:

1. the overall rating was an easily-understood means of quickly communicating the environmental credentials of a product or building element;

<sup>1</sup> source: IBU EPD for Jackodur Plus: EPD-JAI-20150249-IBC1-EN

<sup>2</sup> [http://www.eugeos.co.uk/lifecycle\\_assessment/epd.html](http://www.eugeos.co.uk/lifecycle_assessment/epd.html)

<sup>3</sup> <https://www.bregroup.com/greenguide/page.jsp?id=2069>

<sup>4</sup> <https://www.bregroup.com/greenguide/page.jsp?id=3612>

<sup>5</sup> <http://www.greenbooklive.com/search/scheme.jsp?id=9>

- Green Guide ratings could be used to obtain credits in BREEAM, up to and including BREEAM 2014. Because schemes registered for certification under BREEAM 2014 may seek final certification until 2022, existing Green Guide ratings are still published, although no new ones are issued.

In addition, while it is possible to make some comparisons between the environmental credentials of products based on EPD, these contain a number of environmental indicators, many of which are unfamiliar to many readers.

### 2.3 ABOUT EUGEOS

EuGeos Limited is a small environmental consultancy, founded in 2000 and specialising in LCA<sup>6</sup>. Chris Foster, Principal Consultant at EuGeos, compiled this report. Chris is one of the UK's leading LCA practitioners, working in this field for over 20 years. He has participated in the development of LCA methodology and is active in LCA standards-setting, chairing BSI committee SES/1/5. He has conducted a wide range of LCA and carbon footprint studies for construction products, chemicals, packaging systems, agricultural products and bioenergy schemes.

Chris has carried out LCA to prepare EN 15804-compliant EPD published in the UK BRE and the International EPD<sup>®</sup> System schemes. He is an accredited verifier of EPD for the International EPD<sup>®</sup> System and EPD Ireland and was a member of BRE's "Standing Panel of Experts" between 2011 and 2018.

Chris has extensive direct experience of applying LCA to insulation products, of the BRE Green Guide and the related Certified Environmental Profiles scheme. He was involved in the collection of data for the Green Guide update in 2008, shadowed a number of Certified Environmental Profiles projects, has prepared EN 15804-compliant EPD for XPS products and conducted LCA of different foam-blowing agents including hydro-fluoro-olefins.

## 3 XPS AND THE ENVIRONMENT

### 3.1 REVIEW

XPS insulants contain polystyrene, blowing agent and small quantities of additives. Polystyrene comprises at least 85% of the finished product.

Two example compositions drawn from product EPD are shown in Figure 1 and Figure 2 below.

Product Contents	
Material/Chemical Input	%
Polystyrene	86
Carbon dioxide	5
Dimethyl ether	3
Fire Retardant	3
Additives & Pigments	3

FIGURE 1: PRODUCT COMPOSITION, SYNTHOS XPS INSULANT (SOURCE: BREG-EPD-BRE0058)

Product Contents	
Material/Chemical Input	%
Polysytrene	>95
Blowing agent	4.5 – 5
Colourants & process additives	<0.5

FIGURE 2: PRODUCT COMPOSITION, RAVATHERM XPS INSULANT (SOURCE: BREG-EPD-BRE0081)

<sup>6</sup> www.eugeos.co.uk

For products made from polymers, it is generally found in LCA that the environmental impacts associated with producing the polymer raw materials are much more significant than the environmental impacts associated with the conversion of those polymers to finished products. Because of the importance of the basic materials as drivers of whole-life environmental impacts, the amount of material needed to deliver a specified amount of performance (functional unit) has a significant influence on the results of any LCA. For insulants, the specified amount of performance is a reference insulation effect, and the mass of material needed for different products to achieve this is therefore important. Ratings of insulants in the Green Guide to Specification related to the amount of product for a square metre of insulated surface with an "R value" of 3.

The Green Guide to Specification contains a rating for generic XPS made with HFC (HydroFluoroCarbon or fluorinated hydrocarbon) blowing agent, compiled when the Green Guide was revised in 2008. The overall rating for this "HFC-blown XPS" is E, and individual ratings for the categories covered by the Green Guide are as shown in Table 1.

Category	Climate Change	Water extraction	Mineral resource extraction	Stratospheric ozone depletion	Human toxicity	Ecotoxicity to freshwater	Nuclear waste (higher level)	Ecotoxicity to land	Waste disposal	Fossil fuel depletion	Eutrophication	Photochemical ozone creation	Acidification
Rating	E	A	A+	E	A+	A+	A	E	A+	C	A+	B	B
Weighting in Green Guide (%)	21.6	11.7	9.8	9.1	8.6	8.6	8.2	8	7.7	3.3	3	0.2	0.05

**TABLE 1: GREEN GUIDE ENVIRONMENTAL PROFILE<sup>7</sup> FOR HFC-BLOWN XPS (HFC BLOWN) DENSITY 35 KG/M<sup>3</sup>**

This "HFC-blown XPS" performs very poorly in only two categories, Climate Change and Stratospheric Ozone Depletion, yet it has an overall rating of 'E'. Other polystyrene-based insulants also perform poorly in some categories, for example 40kg/m<sup>3</sup> expanded polystyrene is rated 'E' for Ecotoxicity to Land (8% weighting in the green Guide compared to 9/.1% for stratospheric ozone depletion), and yet it achieves an overall 'A' rating<sup>8</sup>.

The Green Guide online also quotes a "carbon footprint" for generic HFC-blown XPS of 110kgCO<sub>2</sub> eq. over its 60-year life. The Climate Change category accounts for 21% of the overall Green Guide Rating, and if this "carbon footprint" is compared to the equivalent value for 40kg/m<sup>3</sup> expanded polystyrene, which is 16kgCO<sub>2</sub> eq. over its 60-year life, the overall E rating of the HFC-blown XPS becomes easier to understand.

Certified Environmental Profiles for newer XPS formulations made with various blowing agents show environmental performance much better than the generic HFC-blown XPS in the Green Guide. For example the "carbon footprint" for Soprema XPS insulation at density 35 kg/m<sup>3</sup> quoted in BRE Certified Environmental Profile ENP537b is 12.9 kgCO<sub>2</sub> eq. over its 60-year life. The product has an overall "ecopoints" score of 0.052. The boundary between A and A+ for insulants in the Green Guide is approximately 0.049 ecopoints, and that between A and B is approximately 0.08 ecopoints (lower scores are better). This Soprema XPS product would therefore likely achieve an A rating. Other modern XPS formulations perform very similarly under the Environmental Profiles method and have similar overall "ecopoints" scores<sup>9</sup>.

These results point strongly towards the blowing agent as the primary driver of the 'E' rating for the generic HFC-blown XPS, certainly for the Climate Change category. HFC's used prior to 2010 were greenhouse gases, with several - including HFC134 and HFC134a which could be used as blowing

<sup>7</sup> Source: <https://www.bregroup.com/greenguide/> element no. 815320027

<sup>8</sup> Source: <https://www.bregroup.com/greenguide/> element no. 1315320001

<sup>9</sup> See for example, BRE Certified Environmental Profiles ENP508b and 493I



agents - having global warming potentials<sup>10</sup> (GWP) more than 1000 times that of CO<sub>2</sub>, the reference greenhouse gas. After 2010, other fluorinated hydrocarbons became available to replace these substances. These replacements, many of which are a type of fluorinated hydrocarbon called fluorinated olefins (hydrofluoroolefins, HFO) are very weak greenhouse gases. They have much lower GWP than the substances they replaced, and several (for example HFO1234ze and HFO1234yf) have GWP very much less than that of CO<sub>2</sub><sup>11</sup>. In the remainder of this report, the term "HFC-blown XPS" is reserved for the generic product characterised in the Green Guide and using pre-2010 HFC; hydrofluoroolefins are referred to as HFO.

### 3.2 JACKODUR PLUS

While no Certified Environmental Profile is available, it is possible to benchmark the environmental performance of Jackodur Plus against other modern XPS formulations with reference to the EN 15804-compliant EPD published for it in the IBU scheme, EN 15804-compliant EPD published for other current XPS products and to the previous section. Nevertheless this can only be done within limits: as most EPD point out, "EPDs within the same product category but from different programmes may not be comparable"<sup>12</sup>.

Product compositions can be compared. It can be seen from Figure 3 that Jackodur's composition is in line with that of other XPS insulants (see Figure 1 and Figure 2), although blowing agents differ.

Basic material	Mass portion
Polystyrene	90 – 91 %
Blowing agents	8,5 %
HFO 1234ze	~ 70 %
CO <sub>2</sub> and Co-blowing agents	~ 30 %
Flame retardant	1 - 2 %
Additives (e. g. pigments)	< 0,5 %

FIGURE 3: PRODUCT COMPOSITION, JACKODUR PLUS (SOURCE: EPD-JAI-20150249-IBC1-EN)

"Carbon footprints" for product manufacture (cradle-to-gate) can be approximately compared from some EN 15804-compliant EPD for current XPS insulants.

The cradle-to-gate carbon footprint for 0.1 m<sup>3</sup> of Jackodur Plus<sup>13</sup> (reported density 38.4kg/m<sup>3</sup>) is 13kg CO<sub>2</sub>eq, between the 10.2 kg CO<sub>2</sub>eq reported for Dow's Xenergy product<sup>14</sup> (reported density 35kg/m<sup>3</sup>) and the 22.4 CO<sub>2</sub>eq reported for Synthos XPS Insulation Board<sup>15</sup> (reported density 36kg/m<sup>3</sup>). Fossil fuel use can also be compared in this way, with similar outcomes.

It is also possible to estimate a "cradle-to-grave carbon-footprint" for the amount of Jackodur Plus needed for a square metre of surface insulated to R=3 over its 60-year life, from the data provided in the EN 15804-compliant EPD. The resulting value is 11.9 kgCO<sub>2</sub>eq, close to the values reported in the Certified Environmental Profiles of products, and an order of magnitude less than the 110 kgCO<sub>2</sub>eq reported for the HFC-blown XPS in the generic Green Guide profile.

EN 15804-compliant EPD do not cover exactly the same environmental categories as BRE Certified Environmental Profiles (CEP), and use slightly different methods for some indicators. Therefore comparison across all the environmental categories in the CEP is not possible. Some level of comparison is possible for eutrophication; acidification, fossil fuel depletion and photochemical ozone creation.

<sup>10</sup> GWP is a measure of the potency of different greenhouse gases relative to that of carbon dioxide

<sup>11</sup> GWP values for these Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge, United Kingdom and New York, NY, US, p732.

<sup>12</sup> Good examples are the net use of fresh water and mineral resource depletion (ADPE) indicators. Net use of fresh water is almost a whole order of magnitude greater in the BRE EPD BREG-EPD-BRE0058 for 0.1m<sup>3</sup> of XPS then in the industry-wide IBU EPD for XPS, EPD-EXI-20140155-IBE1-EN, while the converse is true for ADPE.

<sup>13</sup> EPD-JAI-20150249-IBC1-EN

<sup>14</sup> EPD-DOW-2013111-E

<sup>15</sup> BREG-EPD-BRE0058

For eutrophication and acidification, Jackodur Plus is very similar to other XPS products for which CEP are available. For photochemical ozone creation and fossil fuel depletion, there is some evidence that Jackodur Plus may be slightly better than those other XPS products. From the evidence examined here, it is not possible to be certain whether such differences derive from the characteristics of the product and its manufacture or from differences in other aspects of the respective LCAs .

For stratospheric ozone depletion - a significant issue in the Green Guide profile of HFC-blown XPS - comparison is more difficult, but there is no evidence that Jackodur Plus is significantly worse than other XPS products for which environmental performance is declared.

## 4 CONCLUSIONS

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The following conclusions can be drawn:

- The poor rating for generic HFC-blown XPS in the Climate Change category, reflected in the whole-life "carbon footprint" which is an order of magnitude higher than that recorded for any current XPS product, is a significant driver of the 'E' Green Guide rating associated with that product. Contributions from the pre-2010 HFC blowing agent are very significant to that rating.
- The environmental performance of current XPS formulations falls in a relatively narrow band when a unit volume of similar density is considered.
- Ratings in the Green Guide scheme for current XPS products, which draw on Certified Environmental Profiles but also take into account thermal performance in use and end-of-life product management, fall within the A or A+ bands of the scheme.
- There is no evidence to suggest that the environmental performance of Jackodur Plus is significantly worse than other current XPS formulations across a number of categories that contribute to Green Guide ratings, including the Climate Change category, when a unit volume of similar density is considered.
- While we have no access to the model used to calculate Certified Environmental Profiles and Green Guide ratings, on the basis of the available evidence collated in this report, it is likely that Jackodur Plus would achieve a rating similar to those for other current XPS products.

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