Case Study

July 2012

elios 2 European Liability Insurance Organisation Schemes

NHBC

7. Paper-Based Insulation

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7.1 Introduction to the technology

Paper-based insulation, also known as cellulose insulation, consists mainly of recycled paper - most commonly newsprint - and therefore has a low environmental impact compared to many other insulation products. It can contain as much as 85% newsprint, and since the remainder only consists of fire retardant chemicals, pesticides and biocides, it can be argued that in fact 100% of the insulative material is recycled.

Paper-based insulation is currently manufactured only in loose form, but is installed in a variety of different ways to suit the application (see section 2).

Paper-based insulation has a similar thermal conductivity to mineral wool, although being somewhat denser it can be more costly to store and transport. Perhaps contrary to expectation, installed paper-based insulation has good fire retardant properties as a result of its closed cell, densely packed structure (as well as the addition of fire retardants).

In some applications the product can enhance the airtightness and soundproofing of a building, and due to its hygroscopic properties it can also be a useful component of 'breathable' buildings.

Paper-based insulation has a similar material cost to mineral wool insulation, but can achieve savings in installation costs in certain applications (for example when blown into irregularly shaped or confined voids).

7.2 Available types of this technology

Paper-based insulation is currently only manufactured in loose form, but it can be categorised by the method of installation as follows.

- **Dry loose-fill**. The dry loose-fill installation method is commonly used to insulate lofts (to practically any depth), and in new wall constructions (usually timber frame). The product is pumped through a flexible hose; it is allowed to settle naturally on horizontal surfaces, or is made to adhere to vertical surfaces by using temporary retainers or membranes that are removed once the insulation has reached the appropriate density. Dry-filled installations can be prone to settling/ slumping (up to 20%).

- **Wet spray-applied**. Wet spray-applied cellulose is used mainly for new wall construction without the need for temporary retainers or membranes. Water is added to the cellulose while spraying (sometimes along with a mould retardant chemical and perhaps a small amount of adhesive). Wet spray installation gives a better seal of the insulated structure against air infiltration and reduces settling problems.

- **Stabilised/conditioned application**. Stabilised, or conditioned, application is sometimes used for sloping roofs or for attic insulation where there is a need to reduce the load on the structure. The cellulose is applied as per wet spray application, but with a much smaller amount of water. In some cases the water may activate a dry adhesive within the product.

There is also a low-dust type of paper-based insulation on the market. By adding a small percentage of oil or similar dust dampener, nuisance levels of dust can be avoided during dry application. This can also be appropriate for homes where the occupants are sensitive to newsprint or paper dust (although new dust will not be created after installation).

Dry loose-fill installation

Wet spray application

7.3 Strengths, weaknesses, opportunities and threats

This section outlines a discussion of the key drivers affecting paper-based insulation.

Strengths

- 'Flows' during dry installation, filling remote gaps and voids.
- Can enhance building airtightness when wet spray-applied.
- Recycled - typically 75-85% newsprint.
- Low embodied energy.
- Raw material contains sequestered carbon, so has negative global warming potential (GWP).
- Zero ozone depletion potential (ODP), because product is not factory-blown.
- Non-irritant, non-toxic and safe to handle, although face masks are worn during installation due to high dust levels.

Weaknesses

- Liable to settlement/slumping after installation (less so when wet spray-applied).
- Up to three times as dense as mineral wool, so can be more expensive to transport and store.
- Weight can cause structural issues in older property retrofit applications.
- Can cause nuisance levels of dust during installation.
- Cannot be used where the structure will be exposed to damp conditions; normally used in timber framed buildings rather than in filled cavity construction.

Opportunities

- Increasing interest in 'natural products' and 'breathing buildings'.
- Growing concern about embodied energy of construction products.
- Increased legislation against competing insulants which are blown with ozone-depleting gases.
- Straightforward end-of life disposal.

Threats

- Possibility that aged-product research may reveal more settling than currently thought.
- Rodent or pest attack may transpire to be worse than predicted.
- Development of rival products with better price/performance ratio.

7.4 Building pathology, defects, and what can go wrong

7.4.1 Invitations to complete questionnaire

An invitation to complete the online version of the Elios II questionnaire was sent to 374 individuals in the following industry sectors:

TABLE 7.1 – Invitations to complete questionnaire

Sector	*Number sent*
Insurance	64
Certification Bodies	10
Accreditation Organisations	4
Builders/Installers	55
Manufacturers	74
Trade Associations	27
Professional Institutes	19
Architects	14
Quantity Surveyors	2
Other	4
Building Inspection Services	13
Government Organisation	22
Housing Associations/Commissioner	16
Consultancies	15
Merchant/retailer	5
Unknown	30
Total	374

In total 70 respondents completed some or all of the questionnaire. This is an 18% response rate.

7.4.2 Responses received

At the closing date of 1st October 2012, 7 responses had been received which related specifically to paper-based insulation. This is approx. 10% of the received questionnaires. The industry sectors of the respondents were as follows:

TABLE 7.2 – Responses

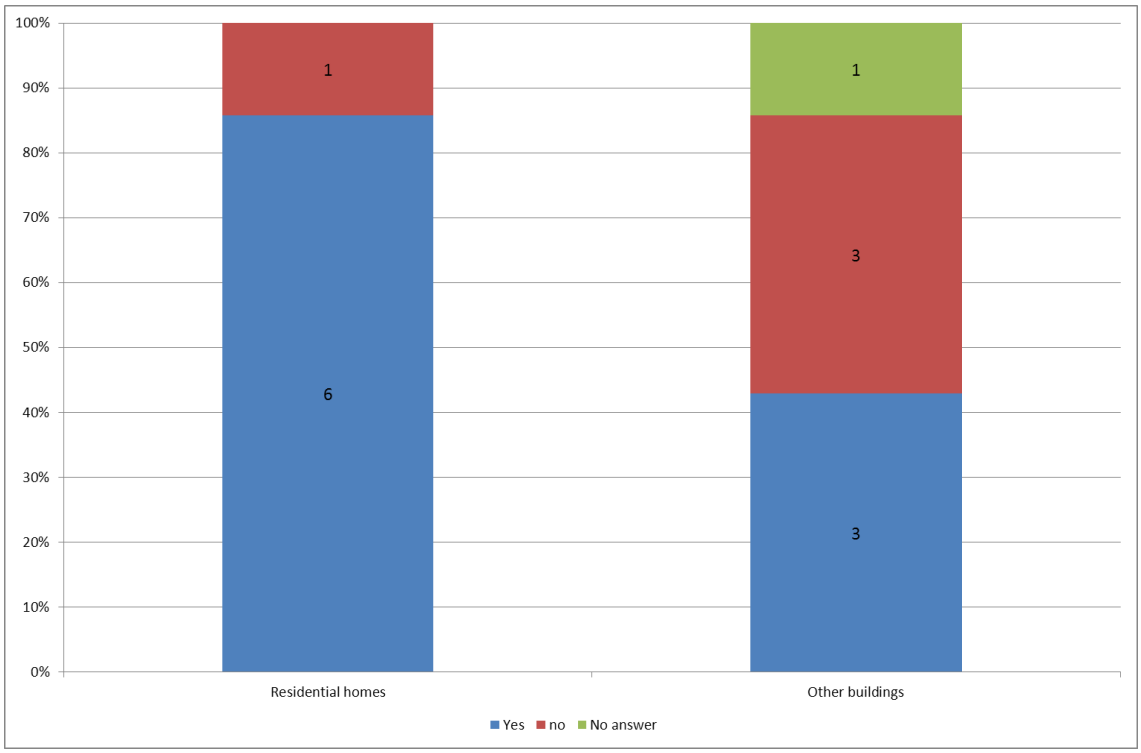
Sector	***Responses received***
Government organisation	2
Architectural practice	0
Housing organisation	2
Manufacturer	1
Retailer/merchant	0
Construction company	1
Installer	0
Building inspection service	1
Certification organisation	3
Insurance company	2
Trade association	0
Professional institution	1
Other (please specify)	3
Business in more than one	4
Total	***7***

3 respondents collectively claimed to have data relating to 26 installations of the technology, of which 1 respondent gave comments about experienced failures or defects.

The following graphs and charts only relate to the people who responded about this technology.

CHART 7.3

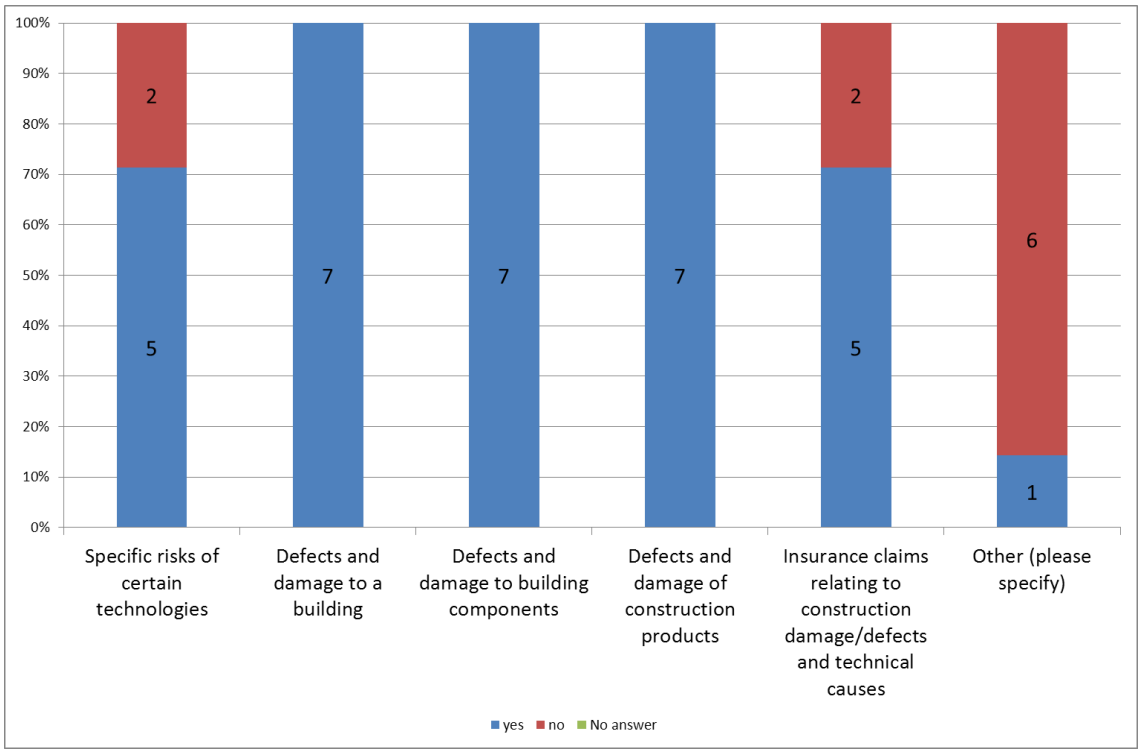
Question asked – *"Does your organisation collect or collate its own data on these types of buildings?"*



This chart shows the number of reporting organisations that collect data on each type of property. This is only for this eco-technology. Organisations may collect data on more than one type of property.

CHART 7.4

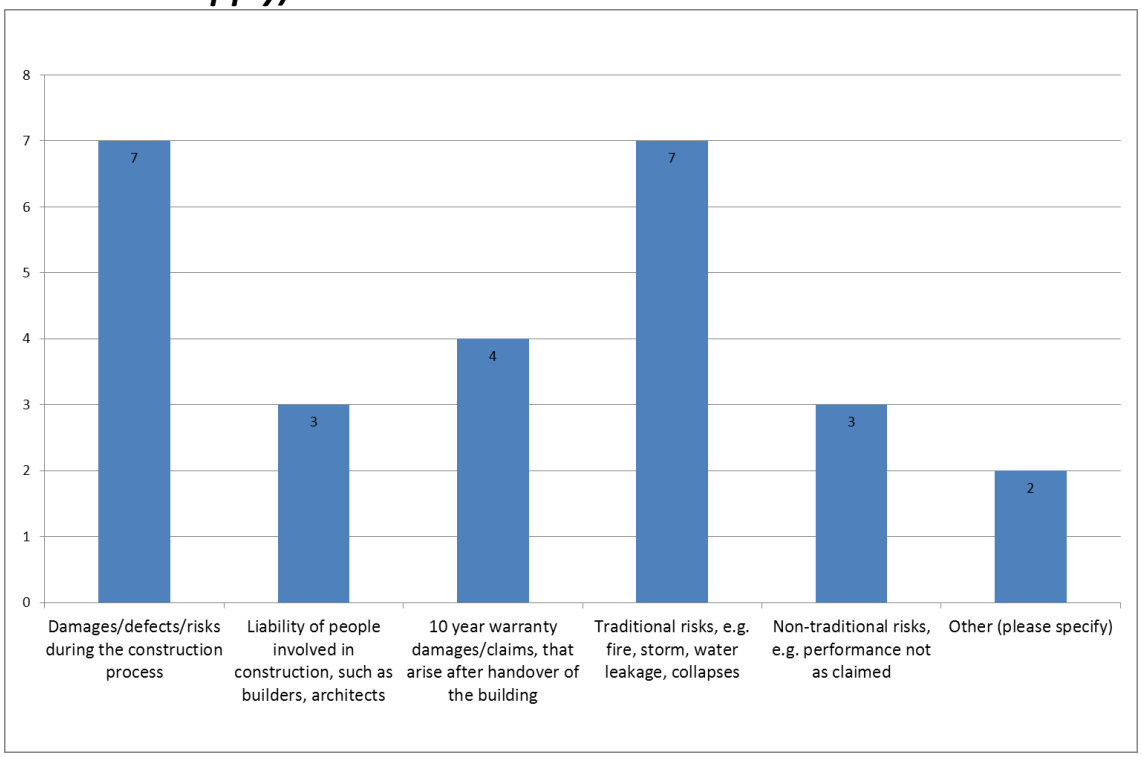
Question asked –*"Does your organisation collect its own data on these issues (please tick all that apply)?"*



This chart shows the various reasons that the reporting organisations collect data, and the number of organisations that gave each reason. This is only for this eco-technology, and not for all 10 technologies. Organisations may collect data for more than one reason.

CHART 7.5

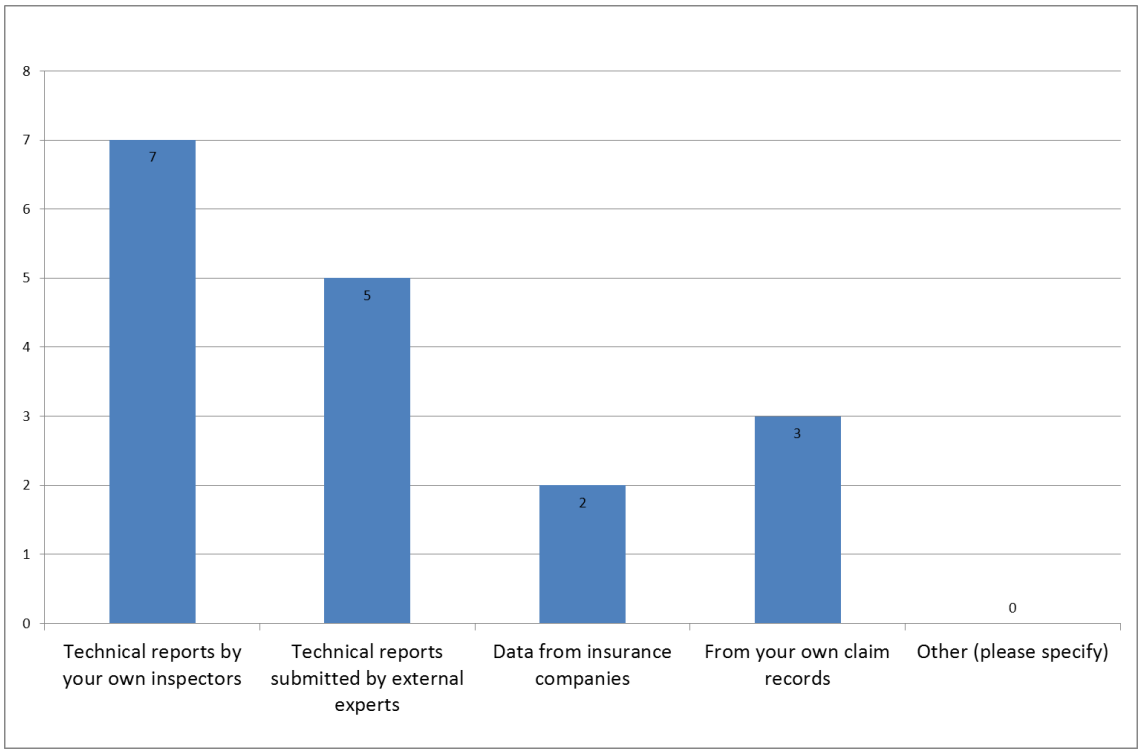
Question asked – *"What kind of damages/defects do the data refer to (please tick all that apply)?"*



This chart shows the number of organisations that reported each kind of damage on which they collect data. Each column represents a different type of damage. This is only for this specific eco-technology, not overall. Organisations may collect data for more than one reason.

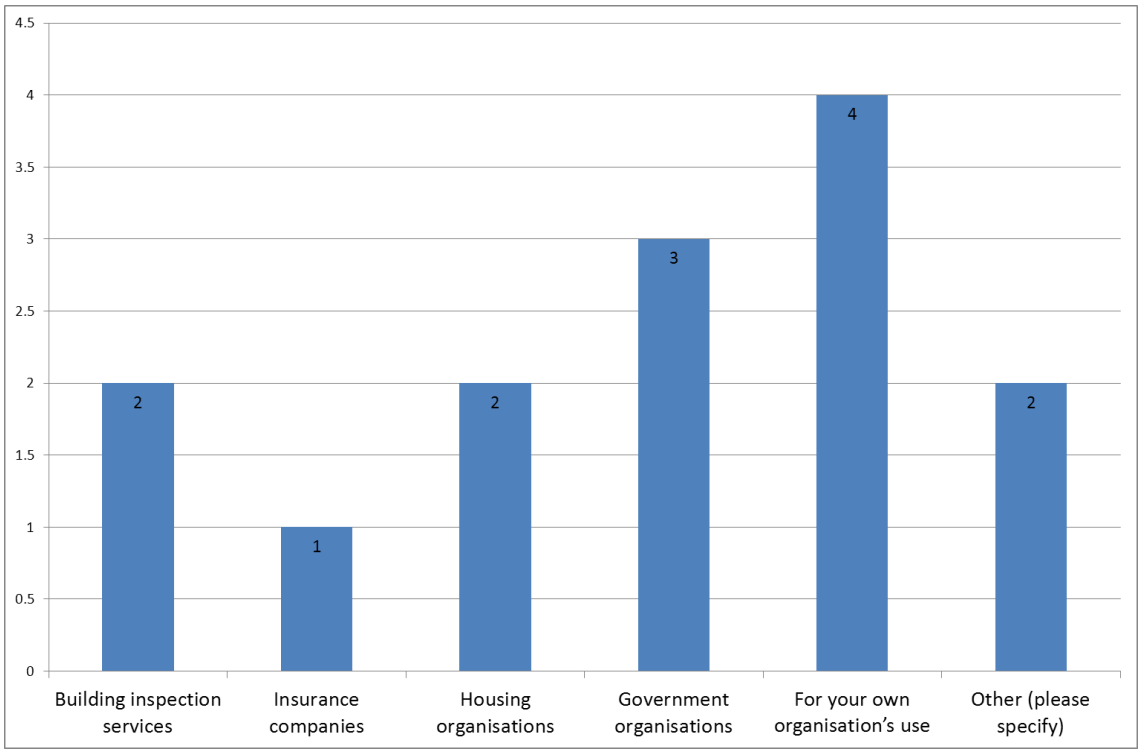
CHART 7.6

Question asked – *"How do you collect the data (please tick all that apply) ?"*



This chart shows the method by which each organisation collects data; each column represents a different method of data collection. This is only for this eco-technology, not overall. Organisations may collect data for more than one reason.

CHART 7.7
Question asked "*For whom do you collect the data (please tick all that apply)?*"



This chart shows the number and type of organisations that reported that they collect data about this eco-technology. Organisations may collect data for more than one type of organisation.

7.4.3 Summary of responses about databases

About their database:

- 6 have a database, all responded;
- 5 provided a date when data collection started
    - 1967
    - 2 in 1970
    - 1 in 1990
    - 1 in 1991;
- 5 carry out statistical analysis of the data;

About data publication:

- 3 make data available on the web;
- None in newsletters;
- 1 in other publications;

About the availability of data, of these respondents:

- 2 publish summary data only;
- 2 publish raw data in any form;
- 0 publish raw data, but made anonymously;

3 comments were passed, as follows:

- *"Confidential to ourselves and the providers - used to inform various services and policy"*
- *"Where we have research projects funded by third parties, there is often a requirement to disseminate findings, under controlled know how and IP, with commercially sensitive information removed."*
- *"Eco-technologies are seldom used in buildings covered by the Building Defects Fund as there is a cost limit per square meter for publicly subsidized housing imposed by the Government. In general it is difficult to place a clear-cut responsibility on one single part in the building project, even after studying the contractual basis. The Building Defects Fund studies the contractual basis solely if it has to pay damages……The Building Defects Fund normally advises against this technology."*

Note that these data comments were in answer about the 10 technologies in general, and may not apply to this specific technology

7.4.4 Reasons for failures and defects

No counts were provided for the numbers of failures for this technology.

The reported reasons for the failures and defects were as follows:

TABLE 7.8

Reason for failure/defect	Number	% of total
Requirement management		
Change in client's requirements	Some	
Misunderstanding of the effectiveness of the technology		
Poor project management		
Inaccurate engineering or architectural data	Some	
Delivery		
Late delivery		
Storage issues		
Awkward packaging		
Poor transport of product		
Installation		
Incorrect design for installation	Some	
Incorrect installation documentation		
Failure in installation	Some	
Commissioning failure		
Operational failure		
Product failure once installed	Some	
Incorrect user documentation		
Misuse of product by end-user	Some	
Performance not as claimed		
Other		
No other reasons were given for failure		
Total		

Note that an installation may have had more than one reason to fail.

7.4.5 Failures/defects commentary

The respondents offered the following general comments and suggestions on the ways in which the failures and defects might be avoided in future:

TABLE 7.9

Reason for failure/defect	Commentary
Requirement management	
Change in client's requirements	
Misunderstanding of the effectiveness of the technology	
Poor project management	
Inaccurate engineering or architectural data	It is another product which requires more attention and application in practice than the traditional insulation blankets or sheets.
Delivery	
Late delivery	
Storage issues	It requires dry storage.
Awkward packaging	
Poor transport of product	

Installation	
Incorrect design for installation	This is another material like normal insulation. A correct airtight execution is very important in order to provide internal condensation. Internal condensation can have disastrous consequences for this material.
Incorrect installation documentation	
Failure in installation	Not following the application requirements
Commissioning failure	
Operational failure	
Product failure once installed	Thermal resistance value is often not attained. Sometimes product damage by internal condensation.
Incorrect user documentation	
Misuse of product by end-user	This could happen when the occupier of the house damages the air tight barrier of the insulation layer.
Performance not as claimed	
Other (specified)	

Two general comments were made:

- *"Damp, fire and degradation"*
- *"SMG have not used this but we did evaluate ~~it~~ its use in developing our closed panel timber frame system, as a factory fitted insulation material. We discounted the product based on concerns with slump and weather damage, during storage and construction on site. Commercially it is more expensive and the thermal values relatively poor, resulting in greater thickness and density to achieve performance. We saw it as a niche option for site fitting applications in the dry, and not a mainstream option."*

7.4.6 Key findings

In summary:

- Experience with paper-based insulation is broadly in line with more traditional products.
- There are no specific, major concerns other than anecdotally.

Lessons:

- Attention to detail is paramount.
- Damp conditions must be avoided.