Case Study

July 2012

European Liability Insurance Organisation Schemes

4. Mechanical Ventilation with Heat Recovery (MVHR)

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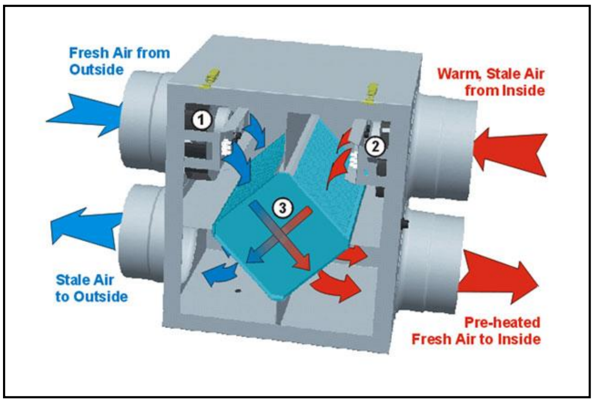
4.1 Introduction to the technology

Heat loss through unintended ventilation is an increasingly important problem in low energy buildings. The issue is generally addressed though successively higher standards in national building codes (Approved Documents L and F in the UK), but such standards tend to encourage more airtight homes to be built (ie. homes with a lower air permeability).

The transition towards more airtight buildings means that purpose-provided ventilation is increasingly necessary. Ventilation options that are able to recover heat from the outgoing exhaust air are therefore increasingly important, as mechanical ventilation becomes the predominant form of ventilation in new buildings.

Mechanical ventilation with heat recovery (MVHR) is a whole-building, ducted, fan-driven ventilation system which recovers a proportion of the heat from the exhaust air and recirculates it back into the house.

MVHR systems consist of a centrally-located fan and heat recovery unit, with flow and return outlets ducted to individual rooms (or to the external environment) as required. Ventilation air is normally extracted from 'wet' areas such as kitchens and bathrooms, and fresh air supplied to living rooms and bedrooms.



Indoor air quality can also be improved using MVHR. Contaminants, pollution and excess moisture, all of which may affect the comfort or health of building occupants, can be removed or reduced. Excess summertime temperatures can be mitigated to an extent.

4.2 Available types of this technology

Because MVHR systems tend to be an installed set of parts, rather than an integrated 'system' as such, and because the resulting installation practices vary widely, the number of different types is large. A typical categorisation of MVHR systems is as follows:

- Location of fan and heat recovery unit:
    - loft or cupboard mounted
    - cooker-hood
- Duct type:
    - rigid
    - flexible
- Specific fan power, watts per [litre per second]:
    - normal (eg. 2.0 W/(l/s)
    - low wattage DC (less than 1.0 W/(l/s)
- Heat recovery efficiency:
    - standard (eg. 66%)
    - Passivhaus spec (at least 75%)
    - very high efficiency (greater than 90%)
- Boost control:
    - none
    - manual
    - automatic (via humidity sensors)
- Summertime heat recovery bypass:
    - none
    - manual
    - automatic (via temperature sensors)

4.3 Strengths, weaknesses, opportunities and threats

This section outlines a discussion of the key drivers affecting MVHR.

Strengths

- MVHR enables good energy efficiency overall, by facilitating airtight buildings.
- Improves indoor air quality, health (e.g. asthma), condensation / mould growth and internal temperatures.

Weaknesses

- Architects/designers do not generally include the details of the MVHR system in their designs; installation often has to be improvised on site as a result.
- Very prone to installation issues – difficult to test/certify a full MVHR system in the laboratory/factory, and systems can fail to meet design values when commissioned.
- Can fail unsafe (eg. no visual indication of fan failure, leading to condensation).
- Lack of filter maintenance is a big concern of property developers.

Opportunities

- Progressively tighter mandated air permeability for buildings will drive take-up.
- Widespread take-up of energy efficient housing (e.g. Passivhaus) could be enabled by a good awareness of MVHR.

Threats

- Resistance by house builders, due to perceived lack of operational understanding by householders.
- Could become discredited if widespread failures occur due to occupant misunderstanding and/or mis-use.
- Over-regulation by governments – especially the emerging tendency to mandate higher ventilation rates for houses.

4.4 Building pathology, defects, and what can go wrong

4.4.1 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 4.1 – 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.

4.4.2 Responses received

At the closing date of 1st October 2012, 11 responses had been received which related specifically to MVHR. This is 16% of the received questionnaires. The industry sectors of the respondents were as follows:

TABLE 4.2 – Responses

Sector	***Responses received***
Government organisation	1
Architectural practice	1
Housing organisation	5
Manufacturer	2
Retailer/merchant	1
Construction company	2
Installer	1
Building inspection service	1
Certification organisation	0
Insurance company	2
Trade association	0
Professional institution	0
Other (please specify)	2
Business in more than one	4
Total	***22***

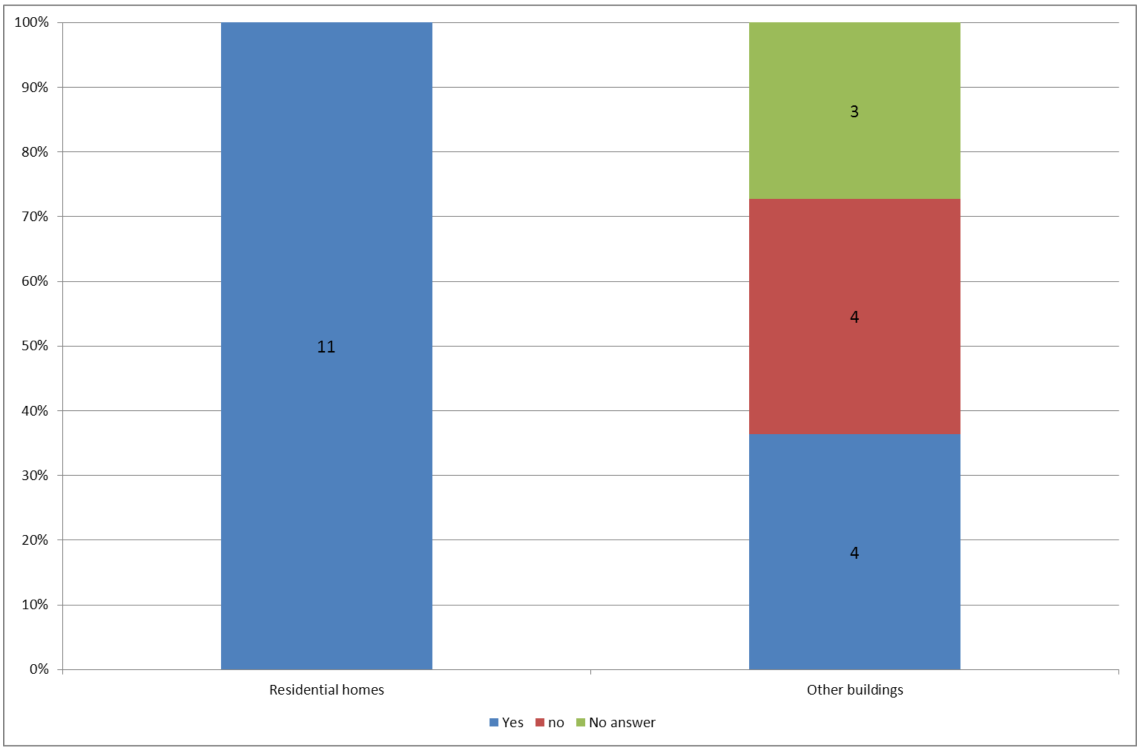
Note that respondent may have recorded that they are in more than one sector

The respondents collectively claimed to have data relating to 651 installations of the technology, of which 41 (6.3%) were said to have experienced failures or defects.

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

CHART 4.3

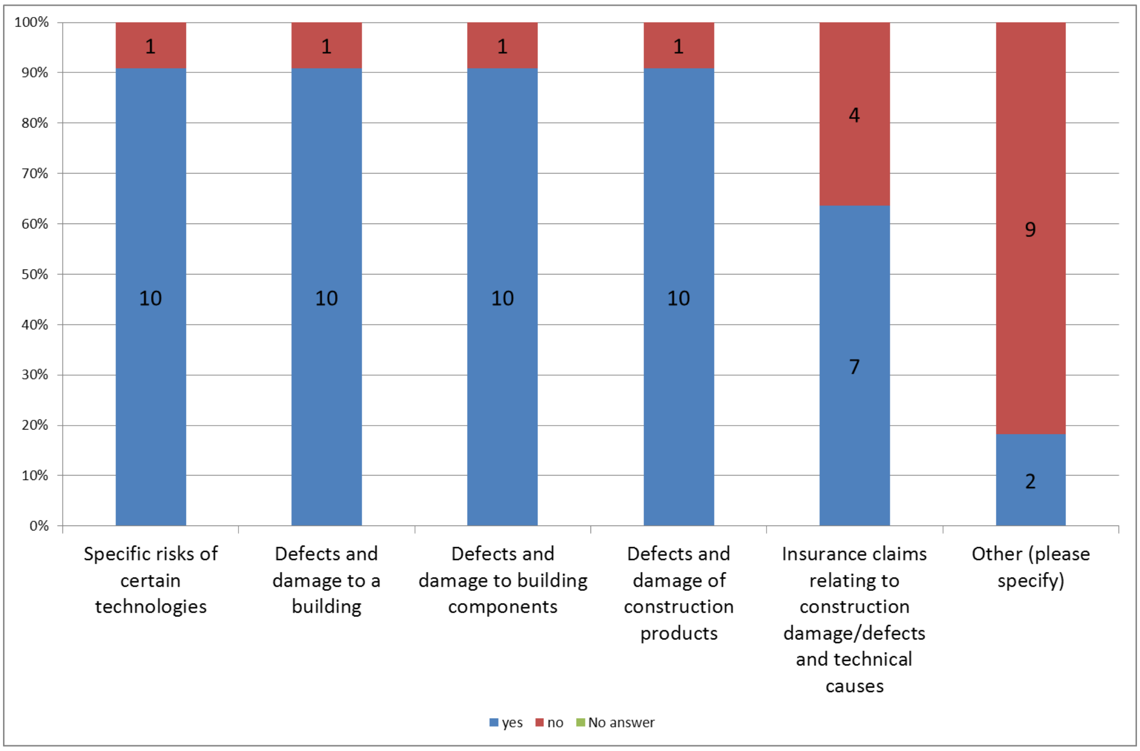
Question asked – *"Does your organisation collect or collate its own data on these types of buildings?"*



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.

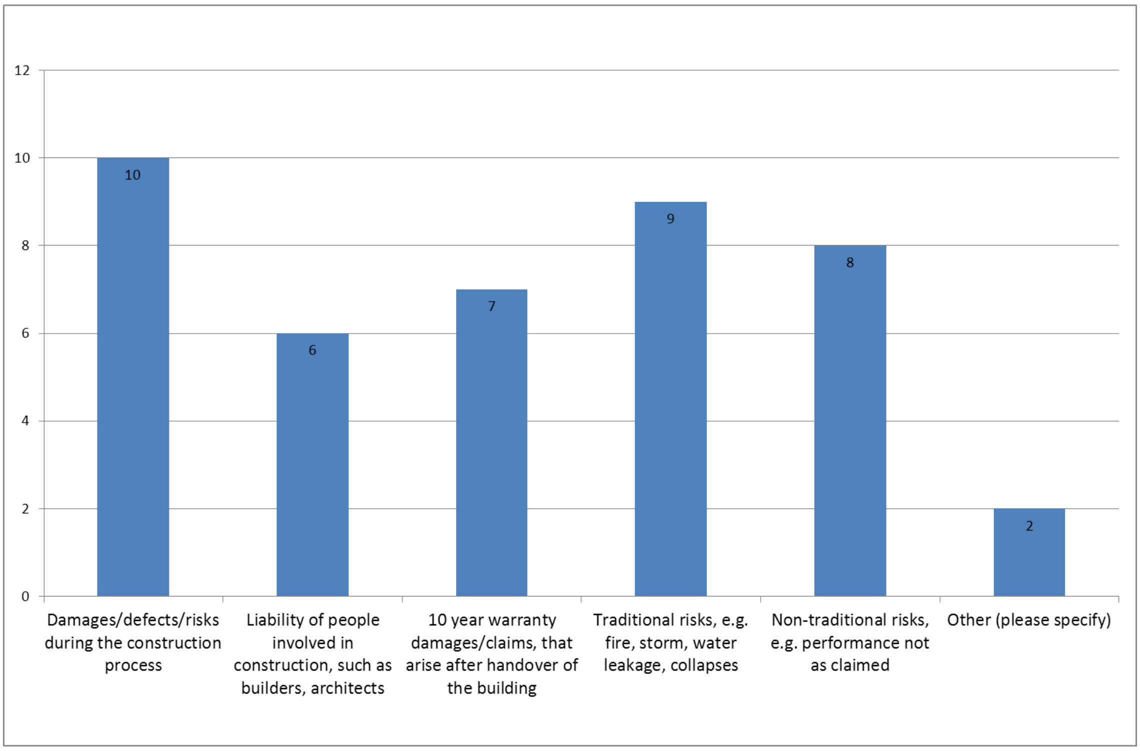
CHART 4.4

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



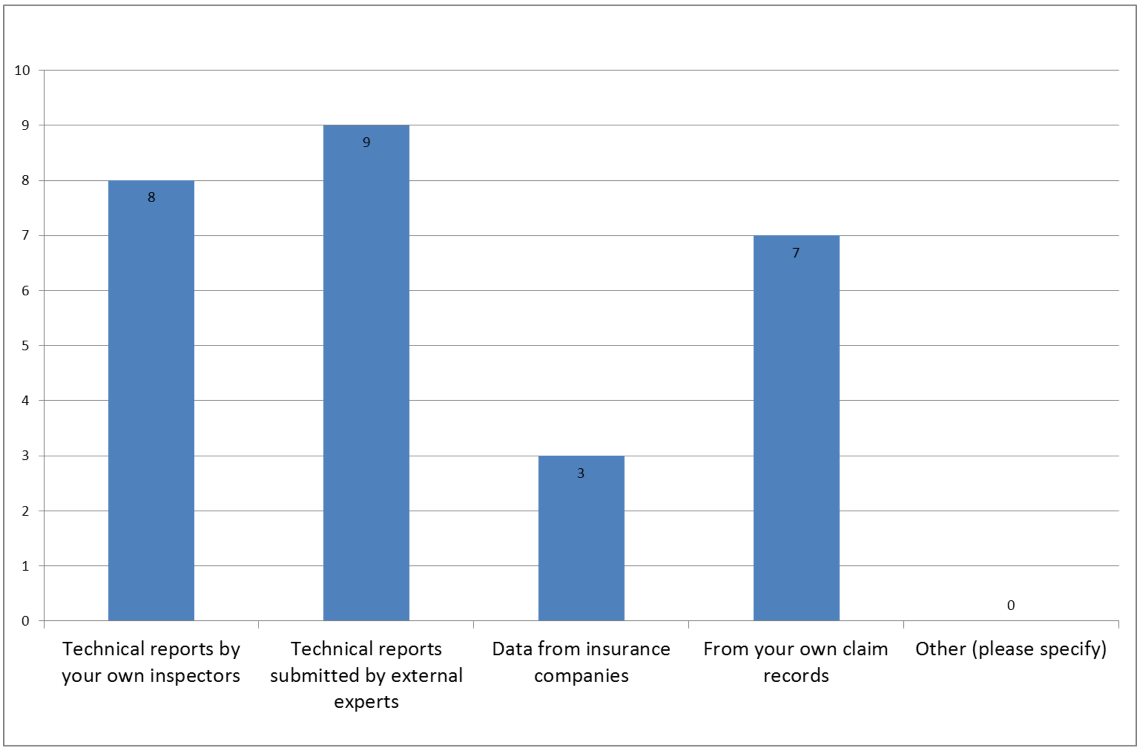
This chart shows the various reasons that the reporting organisations collect data, and the number of organisations that gave each reason. This is only for this eco-technology, and not for all 10 technologies. Organisations may collect data for more than one reason.

CHART 4.5
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.

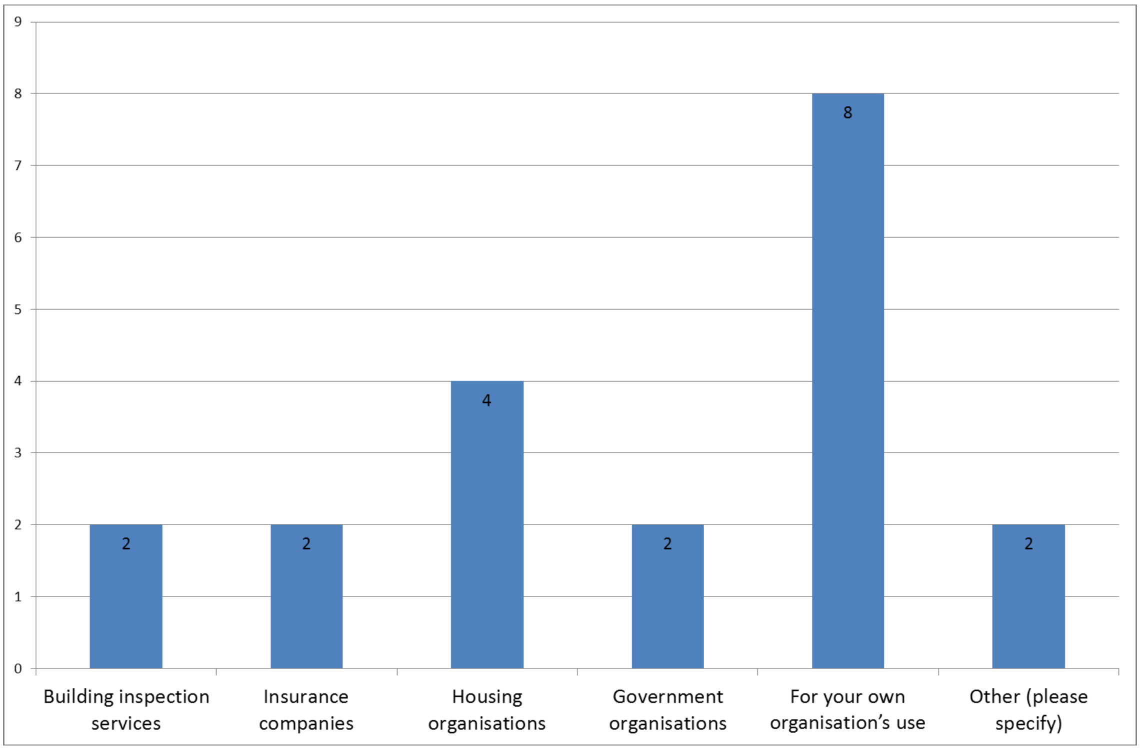
CHART 4.6
Question asked – *"How do you collect the data (please tick all that apply) ?"*



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 4.7

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.

4.4.3 Summary of responses about databases

About their database:

- Only 4 have a database, 2 did not respond;
- 3 provided a date when data collection started
    - 1 in 1990
    - 1 in 1998
    - 1 in 2007;
- 5 carry out statistical analysis of the data;

About data publication:

- 7 make data available on the web;
- 3 in newsletters;
- 5 in other publications (names not provided);

About the availability of data, of these 6 respondents:

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

Two comments were passed:

- *"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."*
- "Only the results of research work"

Finally, note that this question was answered in general about all 10 eco-technologies and may not apply to the specific technology.

4.4.4 Reasons for failures and defects

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

TABLE 4.8

Reason for failure/defect	Number	% of total
Requirement management		
Change in client's requirements	5	0.8%
Misunderstanding of the effectiveness of the technology	16	2.5%
Poor project management	20	3.1%
Inaccurate engineering or architectural data	11	1.7%
Delivery		
Late delivery	3	0.5%
Storage issues	5	0.8%
Awkward packaging	0	0.0%
Poor transport of product	0	0.0%
Installation		
Incorrect design for installation	14	2.2%
Incorrect installation documentation	7	1.1%
Failure in installation	22	3.4%
Commissioning failure	27	4.1%
Operational failure		
Product failure once installed	7	1.1%
Incorrect user documentation	9	1.4%
Misuse of product by end-user	10	1.5%
Performance not as claimed	11	1.7%
Other		
No other reasons were given for failure	0	0%
Total		

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

4.4.5 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 4.9

Reason for failure/defect	Commentary
Requirement management	
Change in client's requirements	Involve homeowners in decisions location changes caused issues with access further down the line
Misunderstanding of the effectiveness of the technology	Technology needs to be better understood generally in construction industry. SAP rating and effectiveness of ductwork system unclear. Workmanship & design issues not properly understood - better training required. The system is sized for everyday operation, but can be insufficient during the drying out phase of extremely airtight properties. in these cases it is was assumed to be fit and forget The seller should present technical data about the heat recovery efficiency according to standards and for several ranges of temperature and air flow rates
Poor project management	The interface between designers and overlaying ventilation ducting was very poor. Poorly positioned ducting and fixing resulting in condensation in ducts
Inaccurate engineering or architectural data	The duct layouts did not fully consider the structure and practical clash points. Using standard housetypes and trying to fit the ductwork into them can cause issue. care not taken during design for maintenance and good access.
Delivery	
Late delivery	Missing parts.
Storage issues	
Awkward packaging	
Poor transport of product	

Installation	
Incorrect design for installation	Always seem to have issues where to locate fan unit - loft space not ideal but often used. Better sub-contractor. Several design iterations progressed before final layouts acceptable. Location of air intake and outlets and insulation to ducts [were wrongly designed]. Outlets and extracts not located in best positions. Duct runs too long. Excessive noise. Absence of summer bypass. Needs better regulation & designers to understand limitations.
Incorrect installation documentation	[Due to shortcomings in the documentation,] none of the systems installed hit the required design values at point of commissioning; all of them needed re- balancing.
Failure in installation	Acoustic noise was a key concern, with noisy ducts in en-suite bathrooms on long duct runs. Operatives on site were not trained. Flexible ducts used for connections not aligned properly. Insulation of ducts not adequate. Flexi duct over used Improve knowledge for the detail of installation to avoid leakage between components
Commissioning failure	Every unit failed to achieve the design requirement the first time around. Remedial work was required to obtain satisfactory tests. Poor commissioning and balancing, extract / inlet rates not correctly set. not meeting Part F requirements Increase the technical responsibility and knowledge for the commissioning technicians
Operational failure	
Product failure once installed	No significant failures, but issues with warning lights, access to filters, condensate traps and noise. Fans burnt out due to being undersized. Unknown, still being monitored
Incorrect user documentation	Poor guides - too intensive. We developed a 1-page quick-start user guide, although this is rarely used. user documentation around control particularly unclear
Misuse of product by end-user	Filters not cleaned / not easy to access. Tenants can switch it off, leading to condensation. Residents fail to understand what system does and how to control speeds and boost function. Understanding the use of boost, when not on a humidistat. Change of

	filters is of concern also. Turning off at night
Performance not as claimed	As-built flow rates and acoustic performance were not as expected. Currently monitoring but seems that fan consumption is higher
Other (specified)	Air permeability of home not low enough to make installation work effectively.

One other general comment was made

- Where possibe we will look to maintain a natural ventialtion strategy. The general public are not familier with mechanical systems in homes, and anecdotally we have heard stories of them being sitched off, never using the boost function such as when cooking, and concern is significnat over requireing occupants to change the filters, which if not done can significantly effect the quality of the supply air.

4.4.6 Key findings

In summary:

- The most significant issue is in commisioning, but that may also relate to a mis-understanding of the use the technology.
- Difficulties in commissioning can also be caused by inadequate or over-complex design; installers should not have to improvise important details on site.
- Any issues of late delivery and storage also relate to poor project management. The causes of poor project managment are more general than the scope of this project, unless it relates to a mis-understanding of the technology.

Lessons:

- Raise awareness of the effectiveness of the technology, both for designers and for users.
- Suggested methods: case studies and articles.
- Raise awareness of the issues of design, installation and commissioning.
- Suggested methods: better documentation and training.