PUR/PIR ASSESSMENT

SAINT-GOBAIN

Frederic Hamilton & Sue Bullock

7 March 2011

COMPONENT IDENTIFICATION & TOXICITY ASSESSMENT





ENVIRON

PUR/PIR Toxicity Assessment Plan

Objective

To identify and complete a high level toxicity assessment of substances related to installation, service life and end of life of PUR/PIR insulation products in order to assist Saint-Gobain evaluate relative issues associated with use of PUR/PIR insulating material compared to alternative insulating products available to the construction industry. ENVIRON also provided a high level risk analysis to provide context for the findings. Study extended to consider manufacture.

Agreed Scope

a) PUR/PIR substance component identification and prioritisation;

b) collation and review of relevant toxicity info

Additional Information

c) evaluation of substance 'importance', considering function, identifiability, alternatives;

d) evaluation of exposure issues, considering uncontrolled and controlled risk

Deliverables

e) health and environment risk-based recommendations*, with commercial relevance*

Toxicity Assessment Limitations and Constraints

- Databases regarding PUR/PIR specific ‘recipes’ and decomposition products are not extensive
- Broad possible specification of PUR/PIR products, encompassing hundreds of possible additives and decomposition products
- Database of available toxicity info limited for some substances (polyols)
- Fire scenario complexity
- Limited scientific data available regarding fire scenarios – preferred method is to consider smoke risk

Substance ID - Functional Analysis - Exposure Schemes

1. Identification of PUR/PIR specific substances related to product lifecycle stages (sources incl: Pubmed literature sources, Alcimed Report, ISOPA, CPI website);
2. Identification of function of each substance within broad categories to support evaluation of exposure. E.g.

Manufacture	Manufacture, installation, service, life and end-of-life	Predominantly fire
-Upstream precursors -Precursors	-Blowing agent -Polymer modulators -UV stabiliser -Heat Stabiliser -Fire Retardant -Colourant	Degradation products (combustion (high priority)/ hydrolytic (low priority))

Toxicity Prioritisation Scheme

- >60 substances identified during extensive web-based literature search.
- Detailed toxicity assessment of all these substances neither possible within scope nor justified based on available information.
- Ranked PUR/PIR lifecycle substance components using a simple scoring method, reflecting key concerns, based on the product of :

  a) Importance of product function (scored 1 to 4) (ENVIRON's interpretation);

  b) Toxicity (scored 1 to 4) ;

  c) Exposure Potential (pre-risk management) (scored 1 to 3)
- Substances with a prioritisation score >12 studied in greater detail

Substance	Product Importance:	Toxicity Score:	Exposure Potential	OVERALL Priority Score:
TDI **Precursor**	**4**	**4**	**1.4**	**22**
Scoring Description	*PIR/PUR foam product importance* ***(As assessed by ENVIRON 1-4)***	***ENVIRON CLP score (1-4)***	***Average score from the identified 5 exposure scenarios***	*Combined product of the assessment components 4*4*1.4 = 22*

ENVIRON

Sensitivity of Toxicity Prioritisation Scheme

- Weighted hazard, exposure (average across exposure scenarios) and importance of product.
- Alteration of algorithm/weighting can have a significant effect on prioritisation outcome. Important to recognise limitations of tool, through sensitivity analysis.
- Score >12 selected as cut-off for detailed toxicity assessment because resulted in a manageable number (17) of substances carried forward to detailed toxicity assessment;
- ENVIRON carried out a sanity check of outcome
  - a) Majority of precursors; b) Selected substances identified by SG with scores <12; c) representatives of functional component groups with scores <12 were carried forward to detailed toxicity assessment.

Toxicity Assessment Approach

- ✓ Check all available CAS numbers in EINECS database;
- ✓ Ascertain available CLP status and labels (ATP 00 and 01);
- ✓ Internet search to check for related CAS numbers;
- ✓ Determine toxicity properties with Toxnet;
- ✓ Determine toxicity properties in GESTIS-database on hazardous substances;
- ✓ Check OEL (European Agency for Safety and Health at Work);
- ✓ Check candidate list (online, most recent version);
- ✓ Check registered substance (ECHA xls list)
- ✓ Check Trade Union Priority List (indicating high priority of SVHC).
- Toxicity assessment ppt updated with results from the process above

Risk Assessment

- Outcome of assessment is extensive volume of data that is a challenge to process, compare and evaluate;
- Information compiled into a matrix to assist review ,discussion and decision-making;
- The matrix highlights, by substance, the following:
  - Significance – 'identifiability'; availability of substitutes
  - Hazard – toxicity to humans; ecotoxicity
  - Exposure Potential – before and after application of risk management measures (RMM)
  - Confidence in available data set
  - Regulatory / public attention
- Example 1: Review by function to identify preferred substance
- Example 2: Refine risk assessment by controlling exposure

Findings – Risk Assessment (Normal Use)

- Substances involved in PUR/PIR life-cycle include raw materials (precursors); PUR/PIR itself, additives with various functions of differing importance, and degradation or decomposition products;
- Many of these substances can be hazardous or, in some cases, very hazardous to health and/or the environment - however, the risk associated with use of these substances in PUR/PIR material can often be managed during normal use by managing exposure. For example, exposure to production workers occurs in an environment that can be controlled. Additional controls to limit exposure of construction and demolition workers and to the public are more difficult to enforce, and measure that require positive action by receptor should not be relied on.
- In general, the risk evaluation shows that risk associated with exposure to hazardous substances associated with PUR/PIR over the lifecycle are manageable. The following key points are noted:
  - It should be possible to control exposure to workers and the environment during production through application of risk management measures required for safe use, thereby limiting risk;
  - Exposure of workers during installation and demolition is possible, but minimisation of dust and avoidance of most hazardous additives (e.g. heavy metals) will limit risk.
  - Exposure to residents and public is expected to be low under normal . Release of substances, including gases/vapours is limited by presence of foil facings, gypsum etc..
  - Fire is a situation where exposure is uncontrolled and therefore of high concern.

Findings – Risk Assessment during Fire

- There is limited data regarding risk from decomposition products of PUR/PIR and alternative insulating materials or the (relative) concentration of those products in smoke during a fire. The main components of concern for PUR/PIR are hydrogen cyanide and CO.
- The potential for decomposition products of a PUR/PIR fire to be more toxic than those of alternative insulating products is identified in the literature, based on expected breakdown products (e.g. increased potential for cyanide), and has been investigated – normally considering overall smoke toxicity. However, limited published data is available to support the finding that smoke or decomposition products from PUR/PIR is more toxic than that from alternatives. Based on existing information, the findings could be that if there is a difference in smoke toxicity, it is not pronounced enough to be easily defined.
- A more genuine a concern is the increased potential for PUR/PIR insulating products to promote fire, which clearly present an immediate and life-threatening risk. This drives the need for effective fire retardants in PUR/PIR products.

Findings – Substitution Considerations

- There are often a range of possible substances / additives that can be used to perform a specific function.
- There has been progress towards substituting the most hazardous substances within the PUR/PIR life-cycle with less hazardous alternatives in recent years. For example HCFCs=>HFCs=>pentane and HDI=>TDI=>MDI, . It is expected that ongoing R&D will continue this trend (e.g. CO_2 as blowing agent) and there is an opportunity for development / selection of less toxic substances to perform key functions.
- Additives with 'essential' functions - for example, fire retardant material– are of great significance for product performance and acceptance. Flame retardants used in PUR/PIR manufacture are generally not considered very toxic (UK endorsement for eco-label), particularly compared to flame retardants in other applications. Any potential trade-off between toxicity and performance must be closely evaluated.
- On the other hand, the function of some additives such colourants might be considered 'non-essential', such that toxic substances can be completely avoided. Use of colourants, UV stabilisers and heat stabilisers in PU board was not confirmed by PU Europe. Individual company decision to include these.
- Irrespective of risk, the most hazardous substances are more likely to be subject to regulatory and public attention for substitution in future. E.g.
  - Toluene Diisocyanate (pre-cursor)
  - MDA (hydrolysis of MDI) Annex XIV REACH recommendation (17 Feb 2011)

ENVIRON - Conclusions

- *<u>Precursors & Polymer Modulators</u>: These substances are generally very hazardous to human health and the environment. Occupational and environmental exposure is regulated and can be controlled. MDI and polyols are the primary polymers for PUR/PIR board. Precursors and polymer modulators are consequently not identified as being of major concern from a risk management perspective. Several of these substances are subject to restriction or identified for regulatory control, and there will be increasing public attention on these substances. However ISOPA and PU Europe informally stated they do not believe future regulatory controls will have a significant impact on the industry.*

- *<u>Blowing Agent</u>: The most relevant agent is pentane. This substance is classified as toxic (CLP: Asp 1) but only by oral exposure. There is thus limited concern from an industrial perspective;*

- *<u>Flame Retardants</u>: In general the flame retardants pose a low level of toxicological concern. However in the case of TCPP there is a need for limiting the risks of dermal exposure during manufacture in relation to effects on fertility and developmental toxicity (EU RAR 2008). Industry identifies use of flame retardants in PUR/PIR board is a concern and one for ongoing development.*

- *<u>Additives</u>: Exposure concern mitigation by utilisation of PPE systems and a controlled manufacturing environment. Recommend low toxicity alternatives are sought to limit risk to construction workers (as well as optimise options for recovery and sustainablility).*

- *<u>Smoke Toxicity</u>: Not specific to PUR/PIR products. PUR/PIR smoke exhibits significant toxicity driven by particulates, HCN and CO. This is comparable to wood smoke. There is widescale uncertainty and ongoing research regarding this point.*

  [International Study of the sublethal effects of fire smoke on survivability & health, NIST, US Dept Com (2001)]

END OF LIFE

Country Specific End of Life Options: Scope of this review

The Material:

- Rigid PUR/PIR Boards manufactured using a non-Ozone Depleting Substance blowing agent
- The waste is assumed to be generated from three main sources: waste from production, construction off-cuts, and demolition waste.

The Scope of the Review:

- Overview of Possible Disposal Options.
- Extensive Literature review
- Discussion with national Waste Regulators & Trade Bodies to identify policy / legislation.
- Discussions with Waste Management Companies and Manufacturers / Producers where applicable.

Overview of End of Life Options: Repair/Reuse

- Salvage of boards for reuse as insulation
- Stage of Use: Demolition

Environmental and Health Implications

- Potential to extend life of product
- May be concerns regarding efficiency of reused product

Current and Future Viability

- Only a small amount of demolition arisings, can be difficult to extract and may be contaminated with other materials (cost/benefit of segregation, incentive)
- Potential move towards mechanical separation prior to demolition, would make easier to extract
- Current site waste management planning for plastic (including foam) is lacking
- Potential issues regarding performance of reused materials

Overview of End of Life Options: Mechanical Recycling

- Ground waste used as filler in new insulation, oil binders and abrasives, insulating mortar and construction blocks, concrete, heat pressed for flooring, and fuel pellets
- Stage of Use: Production and installation offcuts
- Generally undertaken by producers, Isola in Benelux is also a specialist recycler

Environmental and Health Implications

- Extension of product life, although use as binders/abrasives produces further waste
- Precautions must be taken to prevent powder explosions

Current and Future Viability

- Current market is largely as oil binders and adhesive pressing
- Foil facings must be removed prior to recycling (if at installation stage)
- Transport/logistical issues to get small tonnages of bulky wastes to recycling plant
- Unclear cost effectiveness – some companies say only on industrial (>100,000 tpa scale) other successfully smaller amounts (>15,000 tpa) although this is flexible foam
- European company ISOLA looks for waste PU (virgin/uncontaminated from production or trimmings) to recycle into their production (see Benelux country specific information).
- Mobius (German company) reportedly designs and builds recycling equipment for production offcuts

Overview of End of Life Options: Chemical Recycling (1)

  - Several different methods of breaking down constituent molecules to create "new" raw material including; glycolysis, hydrolysis, aminolysis and solvolysis.
  - Stage of Use: Production/installation offcuts, requires clean material of known origin
  - Undertaken by producers, or in research and development

- Environmental and Health Implications
  - Producing "new" molecules effectively re-starts product life cycle
  - Requires large amounts of energy; continuous throughput required to have net positive environmental effect
  - If produces new substances, these may fall under existing legislation e.g. REACH
  - Precautions must be taken to prevent powder explosions
  - Impurities such as flame retardants may have health risks during re-processing
- Current and Future Viability
  - Generally requires continuous throughput, production volumes >1000 tpa, however RAMPF indicates its process can be batch led and cost effective at ca. > 100 t/a
  - Facings must be removed prior to recycling; RAMPF is trialing a removal method at pilot scale to improve the viability of recycling (see Germany country specific information).

Overview of End of Life Options: Chemical Recycling (2)

- Current and Future Viability
  - Very few independent facilities specifically recycling rigid PUR wastes, limited to the rigid foam manufacturers themselves. A recent review (2009) suggested only Aprithane and Regra in Europe pursuing at a commercial scale and they have since "ceased to work on the problem" citing economic reasons. Regra is now operational as RAMPF.
  - Several companies around Europe, particularly France (EFISOL) and Germany (BAYER AG) are evaluating glycolysis technologies (pilot or commercial scale) Bayer progressed to pilot plant stage, not put into production due to cost and quality issue and EFISOL ceased recycling their offcuts, reporting that the plant was not easy to operate.
  - RAMPF/Regra (Germany): recycling polyol is less expensive than producing primary polyol. The company also sets up recycling plants at client facilities.
  - Logstor, pipe insulation company (Denmark): recycles PUR powder from their manufacturing process into new polyols by glycolysis at industrial scale
  - Troy Polymers, Inc. (US) patented glycolysis process for the conversion of mixed PU foam into polyol initiators. They are reportedly pursuing commercial development.
  - Chemical recycling of PU currently not widely undertaken, presumably as the process is still somewhat experimental and issues with cost effectiveness of the existing technologies have been highlighted.

Overview of End of Life Options: Feedstock Recycling & Thermal Pre-Treatment (TPT)

- Break down of polymers into raw materials (pyrolysis/hydrogenation/gasification) for petrochemicals feedstock. Leads to liquid and gaseous products for use in the cement, steel , power and potentially paper industries).
- Stage of Use: Post-consumer – mixed plastics waste stream

Environmental and Health Implications

- Extends the life of the product.
- Not clear how much waste is produced from these processes

Current and Future Viability

- Developing the technology can be uneconomic. Mixed plastics waste used for feedstock recycling where other disposal/recovery options are not possible or economically viable.
- It has been noted that a mixture of several different products may be formed by this technique and this impurity of the final product makes it less viable at an industrial scale
- Currently applied to mixed plastics waste from the packaging waste stream in Germany and is being trialed for other waste streams. Commercial gasification units are in operation across Europe (for TPT, not necessarily for Feedstock production). In trials, nitrogen inherent in PU material has proved beneficial in improving the economics of the process.

Overview of End of Life Options: Incineration and Energy Recovery

  - Co-combustion with municipal wastes. Also as co-fuel in kilns and coal power stations.
  - Stage of Use: Post Consumer / Demolition - undifferentiated waste streams.

- Environmental and Health Implications
  - No segregation (from other plastics) required.
  - Energy resource; content similar to coal (25,000 kJ/kg), slightly less than fossil fuels.
  - 2% weight / 20-30% volume of PU can be included in municipal wastes without an increase in VOC emissions. Presence of additives such as flame retardants could release halogens, dioxins and furans. EU Waste Incineration Directive 2000/76/EC covers incineration/co-incineration plants using solid/liquid waste and gaseous products (pyrolysis and gasification) where these are burnt rather than used as feedstock. There are no requirements specific to plastic wastes; only relating to general emissions.
  - Reducing amount to landfill; Incineration can reduce PU foam waste to <1% volume.
  - Currently regarded as best environmental practice by European PU Associations

- Current and Future Viability
  - Availability of waste incineration plants varies across Europe.
  - Costs for collection, sorting, transport and pre-treatment i.e. current infrastructure may affect the viability of this option.

ENVIRON

Overview of End of Life Options: Landfilling

- Waste disposal site where materials are deposited in the ground. PUR/PIR can generally be disposed of as non-hazardous waste.
- Stage of Use: Production, Installation and Post Consumer / Demolition as can be disposed of without segregation from other materials.

Environmental and Health Implications

- Disposal not recovery
- PU-based products usually do not show any adverse effects on landfill processes, such as degradation or unwanted materials leaching. A US study simulating PU breakdown in landfills found no visible degradation and no aromatic amines were detected.

Current and Future Viability

- Require compliant pre-treatment processing prior to disposal e.g. in the UK, this can be segregation of materials, in Germany, incineration or TPT is required.
- Lightweight nature of materials may make transport costs significant if not pre-treated.
- Facilities generally currently available. Governed by the EU Landfill Directive (99/31/EC); this is interpreted differently on a country basis. E.g. landfill not permitted in Germany unless prior treatment such as incineration is carried our. Most insulants likely to be excluded from landfill due to organic content and/or stability requirements of disposal sites. Expected future trend of increasing costs/decreasing availability.

Current End of Life Option Availability

Option	UK	Germany	France	Benelux	Estimated 2004 EU Quantities PU (all types)
Reuse	Low	Low	Low	Low	No data
Mechanical Recycling	Low	Low - Mod	Low - Mod	Mod	10kt
Chemical Recycling	Low	Mod	Low	None	<1kt (glycolysis)
Feedstock / Thermal Pre - Treatment	Low	Low	Low	Low	2kt (gasification)
Incineration / Energy Recovery	Low - Mod	High	Low - Mod	Mod	203kt
Landfill	High	Low	High	Low	>1000kt

Note: This table is based on ENVIRON interpretation of current data for discussion purposes only.

ENVIRON

End of Life Disposal Options (UK)

- Major Waste Management companies in the UK advise the principal disposal route is currently ***landfill***. Due to the relative cost and availability of the disposal route.
- Sandwich panels (insulated core between metal facing) are currently shredded for recycling in order to recover the valuable metal facing – however, the PUR/PIR insulant is disposed to landfill.
- Information from waste management companies indicated that incineration requires additional pre-treatment (removal of coatings) and is more expensive.
- Mechanical / Chemical Recovery is not currently commercially available in the UK.
- According to the trade body Engineered Panels in Construction (EPIC), studies to explore recycling / recovery options are being carried out by manufacturers.

End of Life Options (Germany)

- Currently main disposal route for PUR/PIR in Germany is ***incineration*** - with energy recovery.
- Landfilling of PUR/PIR material without prior treatment (normally incineration) is not allowed in Germany.
- Chemical Recycling is available for ‘clean’ virgin PUR / PIR residue.
- The RAMPF plant is reportedly not restricted to a certain source or a distinct use and in principle the recycling of PUR/PIR insulation panels from demolition of buildings is possible; however it may not be feasible due to:
  - The long operating life (25 - 50 years) => the polyols are then technically outdated
  - The risk of CFC contamination in older materials (*not a concern for new product*);
- Mechanical recycling is carried out by Metzeler Schaum (a manufacturer of soft PUR foam), however reported that the recycling options also apply to rigid foam.

End of Life Options (France)

- The main disposal route for PUR/PIR is ***landfill*** as it is the most economical.
- A small proportion of PUR/PIR is incinerated (energy recovery due to high calorific value), but the waste stream is not well developed.
- Chemical Recycling is possible; EFISOL has previously operated a chemical recycling installation for PU foam blocks using glycolysis. However ceased operation some years ago.
- Options for mechanical recycling are in place in some plants for 'clean' virgin PUR/PIR residue, e.g. from production off-cuts or production waste
- Waste companies reported disproportionate pre-treatment costs for recovery compared to disposal.

End of Life Options (Benelux)

- Main disposal routes are ***Mechanical Recycling*** and ***Incineration***
- A waste disposal levy which was introduced in the Netherlands in1990. The levy for landfilling is the highest, with lower rates for incineration with / without energy recovery.
- A number of waste management facilities are noted to have various options in thermal treatment or incineration e.g. Shanks Nederland B.V. Rnn Shanks & Indaver Belgium.
- Options available for mechanical recycling of 'clean' virgin PUR residue, e.g. NV Isola Belgium - Producer of PUR insulation and the largest PUR recycler in Europe, accepting virgin / uncontaminated PUR (from production or trimmings).
- No opportunities for chemical recycling identified.

End of Life – Conclusions

- Some re-use of panels (in existing or new use) extends product life.
- Landfill is the preferred option in France and UK where there is limited policy or regulation influencing waste disposal market. Expect this to become less important due to increasing cost (main driver) and pressure for sustainable options.
- In Germany and Benelux, incineration with energy recovery is much more widely utilised due to restrictions on landfill. Currently limited facilities in UK and France. Due to high calorific value, this option is expected to increase in importance.
- Other options including chemical and mechanical recovery are in place, particularly in Germany and Benelux. These are specialist operations, normally sited adjacent to a dedicated source. Feedstock recycling was not mentioned by any of the companies contacted.
- Transport to specialist recovery sites is current obstacle – expected to improve as more facilities become available.

Likely Future End of Life Options

Option	UK	Germany	France	Benelux	Comments
Reuse	Low	Low	Low	Low	No significant change
Mechanical Recycling	Low	Low - Mod	Low - Mod	Mod - High	Increase as further recycling plants constructed
Chemical Recycling	Low - Mod	Mod - High	Low - Mod	Low - Mod	Increase across Europe as manufacturers seek new raw materials
Feedstock / Thermal Pre - Treatment	Low	Low	Low	Low	No significant change
Incineration / Energy Recovery	Mod	Mod - High	Mod	Low - Mod	Increase in UK and France following policy changes / taxation, reduction in Germany as increased recycling
Landfill	Mod	Low	Mod	Low	Decreasing availability of landfill and increasing costs

Note: Projected potential trends over next 5-10 years. This table is based on ENVIRON interpretation of current data for discussion purposes only.

End of Life – Conclusions

- Industry is investing in ongoing R&D in this area. Industry associations strongly oppose disposal to landfill and support recovery of energy at end of life as a minimum. PU Europe points out that very little insulating material (mineral wool, wood fibre, or other) is currently recycled.
- Improving design of PUR/PIR insulating panels to support recovery options;
  - Removal of panels at end of life with minimum contamination
  - Facilitate removal / treatment of facings at end of life
- The European Parliament legislative resolution of 18 January 2011 may also place a requirement to ensure re-use or recyclability of materials after demolition.

PERCEPTION





PUR/PIR country-specific market perception
Scope of review

- Discussions with 2 to 5 key organizations (insurers, NGOs, consumer organizations and industry associations per country by telephone and/or with a formal questionnaire with on an anonymous basis to elicit views on:
  - general position regarding the use of polyurethane and polyisocyanurate foam insulating products in buildings and the construction industry in general?
  - key issues of concern regarding the use of polyurethane and polyisocyanurate foam insulating products
  - any particular concerns regarding behaviour of these materials in a fire, position

Organisations Contacted (Market Perception)

UK		
Passive House Trust (Construction Standard Organisation)	UK Green Building Council (Organisation of NGO and Industry)	Kingspan (Manufacturer)
Eurobond (Non PU Manufacturer)	Green Building Store (Retailer/Contractor)	BRE (Research Organisation)
Green Spec (Green Accreditation Scheme Organisation)	ABI (Insurers Association)	Robust Details Ltd (Accoustic Insulation Standard Organisation)
	BRUFMA (Industry Association)	
GERMANY		
BG Bau (Insurance Association)	Central Association of German Roofers (Trade Association)	Sentinel-Haus Institut (Healthy Housing Association)
	Association of German Carpenters (Trade Association)	
FRANCE		
ADEME (Government Agency)	CSTB (Government Agency)	RAEE (Industry and Government)
Tribu Energie (Energy Consultant)	Logement econome (Energy Saving)	Envirobat (Building Association)
BENELUX		
A33 Architects (Architects)	Dutch Green Building Council (Organisation of NGO and Industry)	BAM Woningbouw (Construction and Planning Consultancy)
Efectis Netherland (Fire Safety)		Conseil d'Isolation(Energy Efficiency

ENVIRON

Country by country perception

- Insufficient data available to support identification of defensible country-specific trends
- There is a very broad spread of (a) **informedness** and (b) **perception** across different organisations in all countries, which are not necessarily related:
  - Many organisations may be 'informed' about and prioritise one aspect of performance, such as thermal insulation, fire safety, acoustic insulation, or sustainability from a raw material / carbon management perspective, often to the partial or total exclusion of others.
  - Level of informedness may also be misleading, since generally this will rely on available information in the public domain that is not objective or based on good science.
  - Several organisations may be well informed, but cannot be considered to have an **objective** opinion – e.g. ISOPA, PU Europe, Eurobond (mineral wool association)
  - The level of **influence** which an organisation can wield is also an important consideration. For example, the ABI and the BRE have a stronger ability to influence long-term choice in the UK than a supplier

Country by country perception

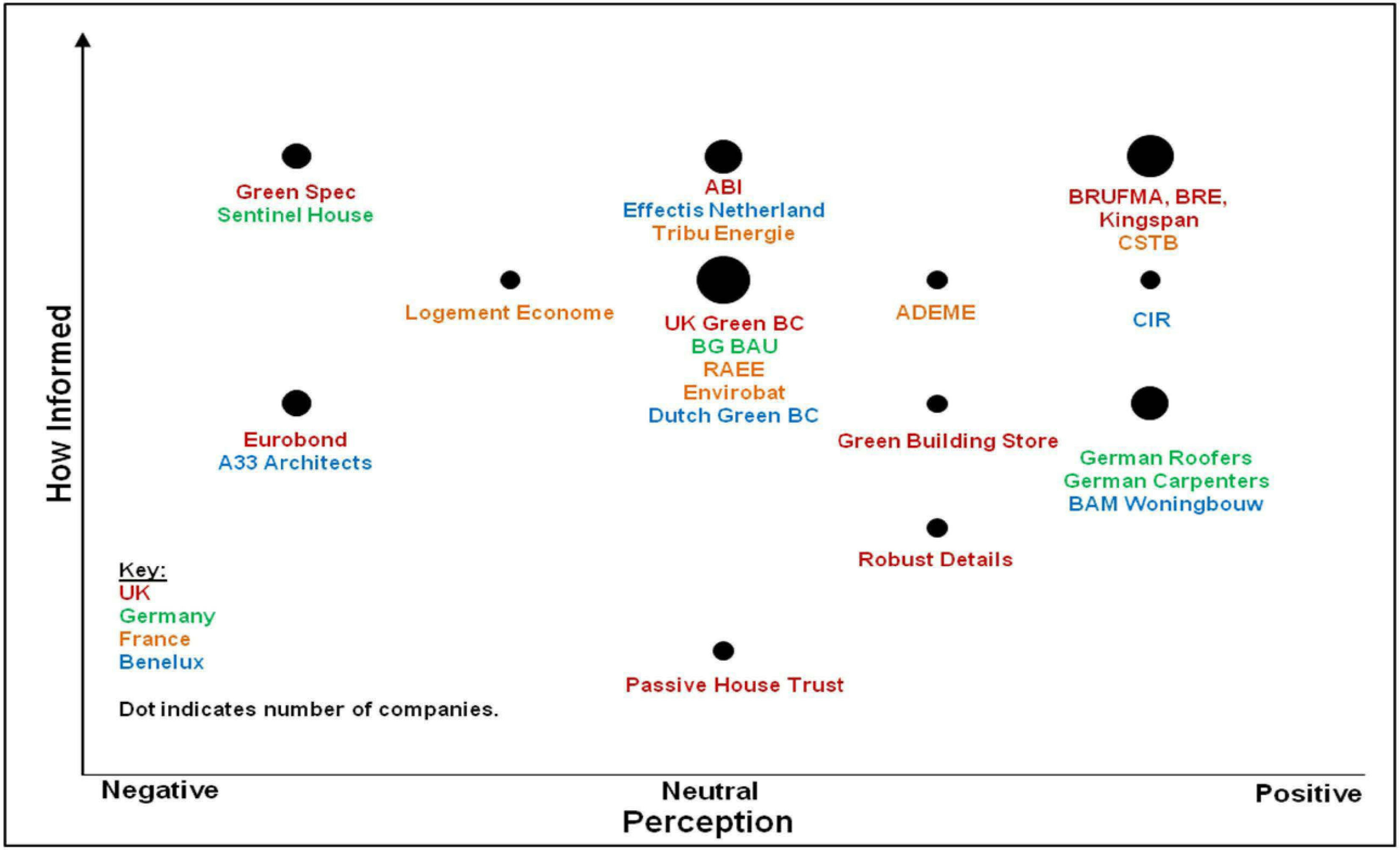
- There is no objective overarching assessment of the performance of PUR/PIR insulating materials across the lifecycle compared to other insulating products to support decision-making.
- Overall, no strong indication that PUR/PIR compares favourably or unfavourably with alternative insulating materials emerged from the review.
- There are many different viewpoints regarding acceptability of PUR/PIR materials, and these are still evolving.
- There is no overall trend in perception between countries
  - UK and Netherlands organisation *appear* to be more interested in sustainability of construction products, including insulating materials, than Germany and France
  - Overall, respondents were neutral to favourably inclined towards use of PUR/PIR
  - Some organisations involved in promotion of sustainable solutions favour 'natural' alternatives
- There is no overall trend in perception between organisation based on level of informedness or influence.

ENVIRON

Overall perception of PUR/PIR insulating materials

- Thermal Insulating Performance - generally considered excellent
  - Driver for increased use of PUR/PIR
- Fire Safety Performance – variable perception from respondants
  - General view that PUR/PIR does not perform as well as mineral based insulation
  - Concern by some (not all) regarding toxic fumes generated during fire
  - Dutch Fire Safety Centre currently investigating the risks of large scale applications (e.g. residential) of flammable insulation materials.
  - Many involved in specification of building materials not concerned provided building standards/code met
- High Embodied Energy – agreed
  - But industry (Kingspan) says 1-3% total energy saving over lifespan
- Raw Material Use – public concern
- Health issues during production – manageable
- General view from insurers is neutral – more information on sandwich panels than board

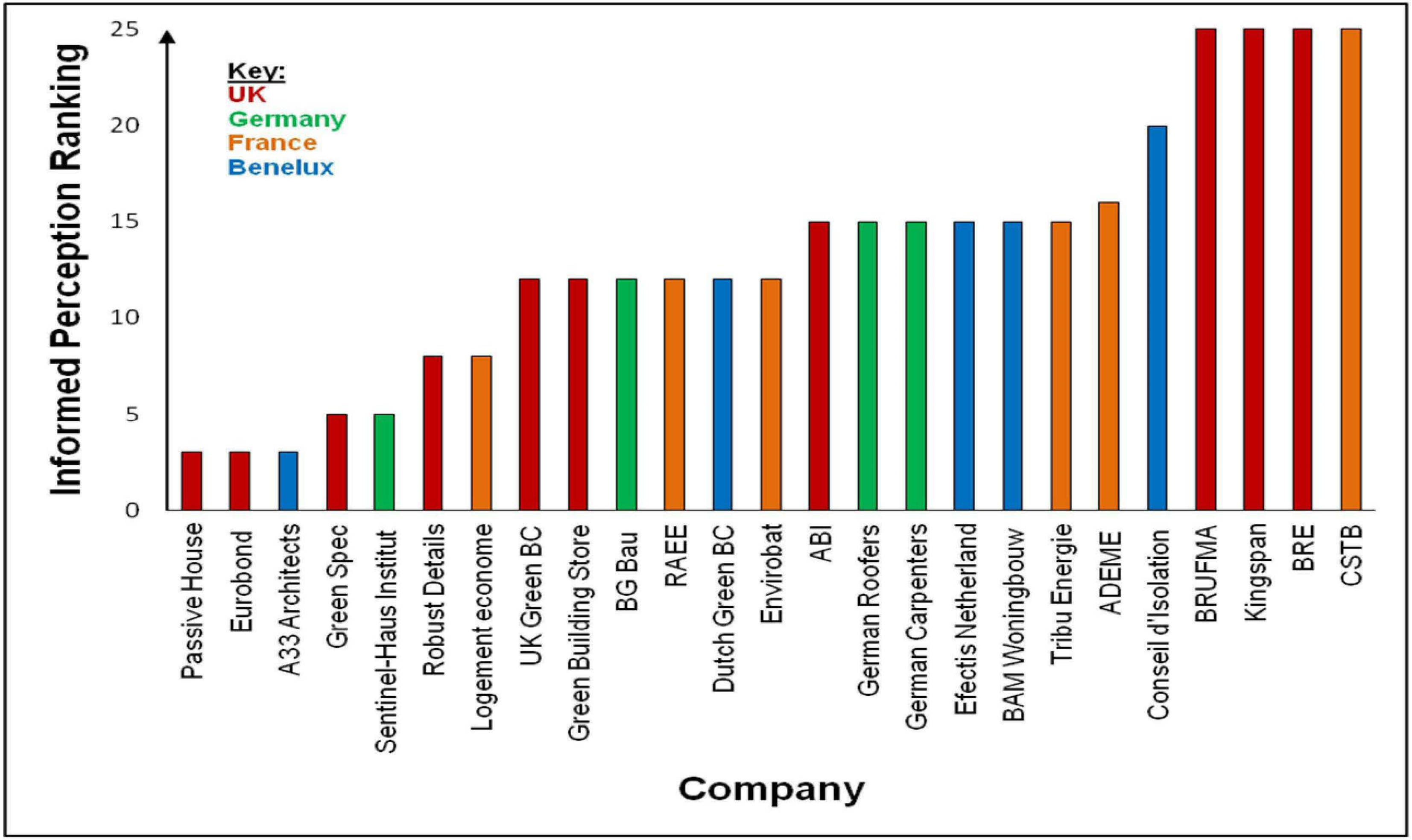
Perception / Informed (All Countries)



Information is based on ENVIRON's opinion of received data.

ENVIRON

Informed Perception (All Countries)

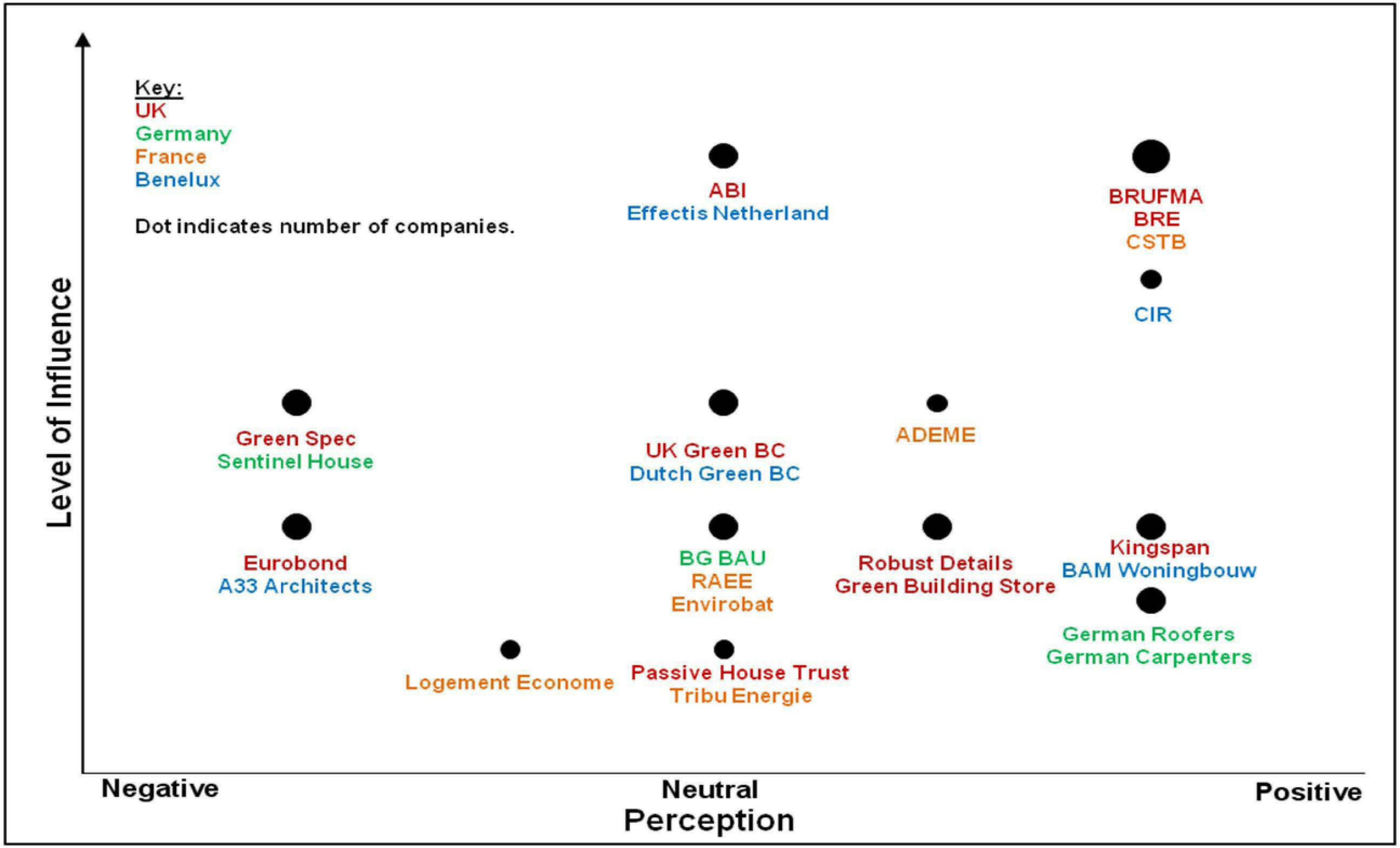


Information is based on ENVIRON's opinion of received data.

"Informed Perception" is a product of "informed" and "perception" rankings.

ENVIRON

Perception / Influence (All Countries)



Information is based on ENVIRON's opinion of received data.

Country by country perception

- UK:
  - General neutral to positive perception
  - Insulating performance, longevity and energy savings widely agreed
    - Highest U values, - 50+ year functional life
    - BRE Green Guide summary generic rating A for sustainability, A+ for specific brands
    - Embodied energy only 1-3% of energy saved over product lifetime
  - Most companies concerned only with energy performance of product
  - Some negative statements regarding environmental impact
  - Mixed views on fire safety
    - Assumption with some traders and distributors that there are no problems with fire safety as all buildings are signed off to building regulations
    - Confusion over fire risk of PU boards – issue is actually with sandwich panels (most reported cases are EPS cores rather than PU) as external cladding or in food processing factories. Fire risk of PU boards not assessed as only one component of wall structure.
    - Polyfoam sandwich panel cores are combustible and when openly exposed to a fire will burn. PUR has better fire performance than EPS, but not mineral wool insulations.

Country by country perception

- Germany:
  - General low risk perception in construction and building industry, as building products and construction material need approval to be allowed for use
  - Application of PUR/PIR insulation panels in construction and building industry mainly dependent on cost-benefit-analysis ($\rightarrow$ expensive but very good thermal insulation)
  - Amendment of the German Energy Conservation Regulation (EnEV) might lead to improvement of market prospects
  - Critical perception of PUR/PIR related risks in specific circles (e.g. Sentinel Haus Institute):

    - Splitting off amines, toxicity of flame retardants

    - Exposure of workers to isocyanates in relation to PUR/PIR processing

    - Ecological problems (raw materials, production and waste management)

Country by country perception

- France:
  - General low risk perception in construction and building industry, as building products and construction material need approval to be approved for use
  - Application of PUR/PIR insulation panels in construction and building industry mainly dependent on cost-benefit-analysis (→ expensive but very good thermal insulation) and project specific criteria (few cm thickness only)
  - Amendment of the French Energy Conservation Regulation (RT 2012 – Grenelle de l'Environnement, Energy performance survey DPE) might lead to improvement of market prospects
  - Development of new performance certifications/labels for both products (eg ACERMI) and buildings (eg BBC – low energy consumption building)
  - Critical perception of PUR/PIR related risks in specific circles
    - Toxicity of combustion products in case of fire (flame retardants, etc.)
    - Ecological problems (petrochemical raw materials, production and waste management)
    - Poor acoustic performance of PUR boards (may be a limiting factor in material choice)

Country by country perception

- Benelux:
  - Building sector in favour of PUR/PIR insulations due to thermal performance and related ability to provide a thinner layer of insulation compared to some other products
  - However, sustainable builders prefer natural materials
  - New regulatory demands for energy efficiency in buildings since 1st January 2011; may change preference towards better-performing materials such as PUR/PIR
  - Some concern over behaviour in fire (smoke development)
  - Netherlands Fire Safety Centre currently performing an investigation regarding fire safety of PUR. This publication may lead to a change in current Dutch regulations regarding (restricting) the use of flammable insulation materials.