BNPB2: Plasterboard - waste management

Version 1.1

This Briefing Note and referenced information is a public consultation document and will be used to inform Government decisions. The information and analysis form part of the Evidence Base created by Defra's Market Transformation Programme.

1 Summary

This Briefing Note presents information about plasterboard waste generation, the options for its management and the types of end use available for it.

2 Plasterboard waste generation

Plasterboard waste is a major component of construction and demolition waste, and will be generated during the construction, refurbishment and demolition phases for both housing and commercial sectors. In construction, plasterboard and the waste generated from its application will become apparent during the internal finishing stages of the project. Contractors, typically, produce most of the waste over a very short period of time and many skip loads of construction waste will contain predominately plasterboard. It has been assumed that there will be 12% wastage of plasterboard when installed (either at the new build or refurbishment stages). This can be largely due to offcuts (see Briefing Paper 2).

With regard to service life planning, Table 1 states the average lifespan for the components of a building.

Table 1 Average lifespan[1]

Type	Frequency of replacement
Fixtures and fittings	Every 5 years
Internal fabric (eg plasterboard)	Every 15 years
Services	Every 20 years
Cladding	Every 30 years
Structure	60 - 200 years

The use of plasterboard began in the 1960s and 70s, and therefore refurbishment and demolition activities will see increasing amounts of waste plasterboard product,

[1] Personal communication with BRE Centre for Whole Life Costing.

reflecting the rising use of plasterboard since that time. The amount of plasterboard used will depend on the refurbishment cycle of the building, which will be based predominantly on its use. Other conditions that will affect the replacement intervals of plasterboard include: quality of components, design level, work execution level, indoor environment, in-use conditions and maintenance level[2].

The ODPM estimates that in 2003 there were just over 21.5 million households in England and over 25.5 million in the whole of the UK. Regional Spatial Strategies for all the English Regions set targets of building 154,726 new houses per annum to 2016. The Government wants to ensure regional housing targets are met and has made a commitment to build an extra 200,000 homes over and above those already set out in Regional Planning Guidance by 2016, as part of the Sustainable Communities Plan. This would increase total house building rates to around 180,000 per year (completion averages for 1996 - 2001 were around 141,000 per year)[3]. Demolition of dwellings between 1996 and 2001 were estimated to be 100,000, an average of 20,000 dwellings per year[4].

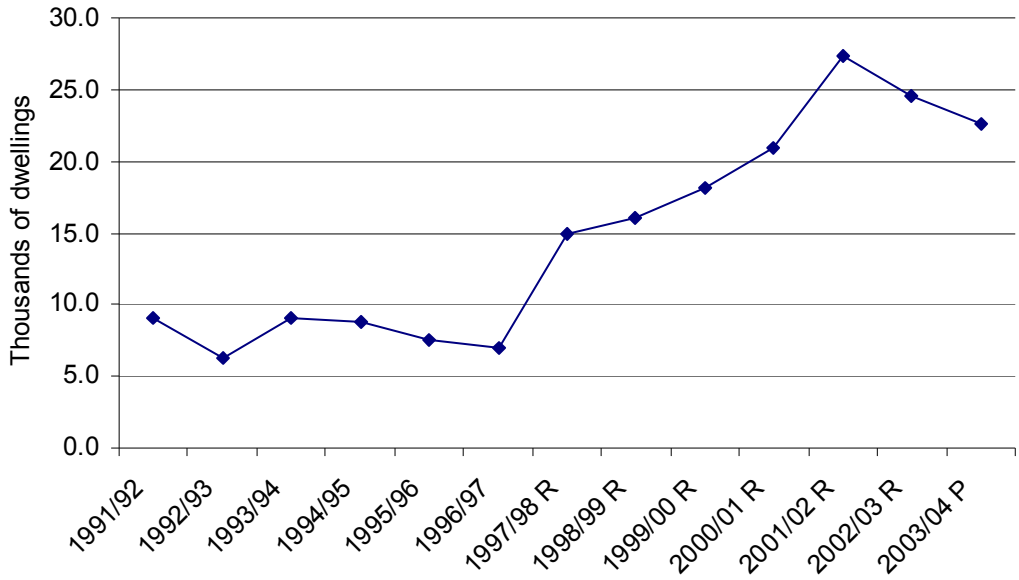
An assessment has been made for plasterboard product waste from installation at both a new build stage and a refurbishment stage. No assessment has been made of the amount of plasterboard product removed as a waste from demolition and refurbishment activities. Better data are required before this can be carried out. The amount is expected to be a lot higher than plasterboard waste generated from installation. Demolition and refurbishment will, during the strip-out phase, produce 100% plasterboard waste while only 12% of plasterboard installed during new-build will be waste.

As presented in Table 8 in Briefing Note BNPB1, the volume of plasterboard waste generated from new dwelling completions in 2003, based on 12% plasterboard wastage, was 209,000 tonnes. This figure is predicted to increase by 2020 to over 379,000 tonnes of plasterboard waste.

As can be seen from Government statistics, the number of dwellings being converted or demolished has increased dramatically in recent years, although indications are that a fairly consistent level has now been attained. The amount of plasterboard waste being generated from these activities may be considerable, and this volume needs to be quantified to gain a clearer indication of the total amount of plasterboard waste that needs to be recycled or reprocessed.

Figure 1 ODPM statistics on dwelling losses due to conversions and demolition 1991 - 2004

[2] According to BS / ISO 15686-1 (general principles).
[3] EAC (2005), Housing: building a sustainable future.
http://www.publications.parliament.uk/pa/cm200405/cmselect/cmenvaud/135/13502.htm
[4] English Housing Condition Survey, ODPM 2001.



3 Plasterboard waste management options

The waste hierarchy provides a theoretical framework which should be used as a guide for ranking waste management options. The UK Government advocates the use of the waste hierarchy as a guideline following the options of reduce (minimise), re-use, recycle, recover and finally disposal. Most legislation places a focus on dealing with waste through the waste hierarchy. The waste management options for plasterboard are discussed below using the structure of the waste hierarchy.

3.1 Plasterboard waste reduction

Previous studies have shown that offcuts are the major cause of plasterboard waste from new build construction (at about 90%) followed by unsuitable storage (at around 6%)[5]. Offcuts could be reduced at an early stage in the design process, through designers and architects designing buildings using standard plasterboard sizes. For special projects, and where the volume is large enough, manufacturers can produce bespoke sized plasterboard to speed up construction and reduce waste on site from offcuts[6].

On one construction project[7], plasterboard was specially designed and made by the manufacturer so that a single rather than a double skin could be used: one 15 mm panel rather than two 12.5 mm panels. The panel would withstand wear and tear and was pre-sealed, eliminating skimming and reducing the amount of paint used. Overall, plasterboard raw material inputs were reduced by around 50% and cost

[5] Greenwich Millennium Village Phase 2A Final Report, Confidential.
[6] GPDA, Healthier building with gypsum products: No. 4 Reduction of Waste, 1998.
[7] Casella 2002 - Casella Stranger, Forum for the Future, Carillion plc. Sustainability Accounting in the Construction Industry, 2002.

savings on labour and paint were achieved. On another construction project[8], ordering plasterboard to size reduced the wastage level to 3.5% of the material used on site (typically this is about 12%).

Other issues that help to minimise plasterboard waste generation on construction sites can be addressed. Poor material storage and handling practices on site can create waste due to physical damage from incorrect storage with insufficient protection from the weather, impact from dropping, collision, and accidental damage from moving plant. Plasterboard should be stored on a dry level surface, stacked flat. Boards which are stored for handling later by fork-lift should be supported at regular intervals and at their ends so that they are not damaged by deflection. Some sites may be confined such that storage space is at a premium. In these cases, phased delivery, just-in-time delivery and direct delivery to the workspace may be the best solutions[9]. Poor sequencing and co-ordination of trades can lead to subsequent trades removing or damaging plasterboard because there is still work to be completed behind the finished surface[10].

Reduction of plasterboard waste from refurbishment will only be possible by increasing the lifespan of plasterboard products or reducing refurbishment intervals.

3.2 Plasterboard waste re-use

Offcuts of plasterboard waste should be used wherever possible on site (new build and refurbishment). This will be dependent upon the product being suitable for re-use (ie it is of an appropriate size, good quality, edges allow jointing). Central areas on site can be set up to store offcuts for re-use. Alternatively, main contractors and subcontractors can re-use plasterboard on other projects, if an appropriate storage area is set up.

3.3 Plasterboard waste recycling

Plasterboard offcuts can be recycled and reprocessed if they are free from contamination. This requires segregation at source. The Landfill Directive should encourage the segregation of plasterboard at source (see Briefing Note BNPB3).

The gypsum core needs to be separated from the paper liner to which it is bonded – this requires investment (normally by the plasterboard manufacturer) in expensive specialised equipment. All of the plasterboard manufacturers have or are setting up plants to enable plasterboard waste to be recycled back into plasterboard. Some of these recycling sites are managed by a third party and do not accept certain types of plasterboard waste. For instance, moisture-resistant boards cannot be recycled owing to their composition. The schemes typically work on reverse logistics and collection charges are made.

[8] CIRIA, Demonstrating waste minimisation benefits in construction, 2001. CIRIA publication number C536, case study report C536/6.
[9] GPDA, Healthier building with gypsum products: No. 4 Reduction of Waste, 1998.
[10] Ibid.

Take-back schemes for recycling of plasterboard waste from new build have been in existence since 2002. One major contractor has been segregating plasterboard offcuts since 2002, and this is reflected in its Corporate Social Responsibility Report. In 2004, it segregated 72% of its plasterboard waste (4,831 tonnes)[11].

The take-back schemes are dependent upon the quantity and quality of plasterboard waste produced and currently manufacturers will only take back their own plasterboard products. Return load haulage is used wherever possible, but the logistics of hauling scrap material are quite different to those of moving pallets of plasterboard[12].

It has been indicated that there are constraints on the processing capacity to recycle plasterboard waste. The other main hurdle is transportation. With only a few plasterboard manufacturing plants in the UK, waste generated at a long distance from these plants is likely to prove uneconomical to recycle, at least in the short term.

The Waste and Resources Action Programme (WRAP) have been awarded funding from the Business Resource Efficiency and Waste (BREW) programme to develop a number of initiatives aimed at supporting the segregation, collection and recycling of waste plasterboard, and the development of end-market uses for the resulting recycled gypsum. The market potential for more recycled content is large and WRAP has identified that plasterboard has a significant potential for increased recycled content.

Plasterboard waste from refurbishment and demolition is much more problematic as it is often contaminated with, for example, wallpaper, nails, pieces of timber, and paint. Currently, recycling plants do not take material from demolition owing to contamination. If the boards were stripped out before the building was demolished, their inclusion could be possible, as long as fixings are removed and the boards are relatively uncontaminated[13]. The increasing use of dismantling or deconstruction techniques should make plasterboard easier to segregate. Research is being undertaken in the Netherlands to learn about and gain greater understanding of the practicalities of this for further development[14].

In countries such as the USA, Canada and Germany, where landfill disposal charges are much higher than in the UK, there is already an economic incentive for recycling plasterboard[15] from refurbishment and demolition. In these countries, the recycling plants are able to purchase plasterboard waste from demolition contractors at a price that makes the cost of separation from other waste products attractive[16].

4 Potential end markets for plasterboard waste

[11] Taylor Woodrow Construction, Corporate Social Responsibility Report 2004.
[12] Personal communication with British Gypsum.
[13] Personal communication with Lafarge.
[14] Lafarge website, www.lafarge.com
[15] GPDA, Healthier building with gypsum products: No. 4 Reduction of Waste, 1998.
[16] Personal communication with British Gypsum.

End markets for gypsum (not necessarily plasterboard waste) other than back into plasterboard manufacture have been identified and include: land applications, composting and cement production. Those markets that have had less investigation but with potential include sludge drying (bulking and drying), water treatment (settling of dirt and clay in murky water), cattle food additive (boost milk production), animal bedding (moisture absorption and odour abatement), flea powder (replace virgin gypsum use), grease absorption, cat litter (moisture absorption and odour abatement) and athletic field marking.

4.1 Soil conditioner

Waste plasterboard from construction, refurbishment and demolition can be used as a soil conditioner via landspreading. Specification (eg size and level of contamination) and the method of application are interdependent. There are different ways of applying gypsum to land (eg using a spreader, tilled). Depending on the application methods, gypsum in the form of powder can be used or the plasterboard can be chopped up and the paper liner removed so that the gypsum can be returned to the soil as an improver. Gypsum neutralises alkaline soils and improves the soil permeability, helping the penetration of water and air which are prevented from circulating in alkaline soils. It also adds sulphur and calcium and has a catalytic effect, maximising fertiliser utilisation. Gypsum can also reduce the harmful effects of sodium salts.

Landspreading (or land treatment) represents an economical and, when properly controlled, environmentally safe way of recovering value from a variety of organic wastes. Most agricultural wastes and by-products are organic – for example, manure, slurry, silage effluent and crop residues – and landspreading is the normal waste management option for these materials. Sewage sludge and certain industrial wastes – for example, paper sludge, food processing waste and non-food waste such as lime and gypsum – may be spread on land beneficially. The Framework Directive on Waste classifies landspreading as a waste recovery operation – land treatment resulting in benefit to agriculture or ecological improvement[17]. All of the above wastes, which include gypsum, provide valuable nutrients which allow farmers to reduce the amount of inorganic fertiliser applied, and can lead to improvements in soil structure.

There are also potential disadvantages to landspreading wastes. Used inappropriately, landspreading may lead to soil contamination from the concentration of some elements, may lead to deterioration in soil structure and may pollute water (including groundwater)[18].

[17] Department for Environment, Food & Rural Affairs (Defra), Waste Strategy 2000 for England and Wales Part 1 & 2. Chapter 5: Waste management options, http://www.defra.gov.uk/environment/waste/strategy/cm4693/12.htm
[18] Department for Environment, Food & Rural Affairs (Defra), Waste Strategy 2000 for England and Wales Part 1 & 2. Chapter 5: Waste management options, http://www.defra.gov.uk/environment/waste/strategy/cm4693/12.htm

Under the Waste Management Licensing Regulations 1994, the landspreading of certain wastes is exempt, as a waste recovery operation, from waste management licensing controls if it complies with certain rules. The exemption applies if the landspreading of the waste will result in benefit to agriculture or ecological improvement, no more than a specified amount of the particular waste is applied to each hectare of land (250 tonnes in any 12 months), and the Environment Agency is informed in advance of the proposed landspreading. The requirement to demonstrate ecological improvement guards against the potential disadvantages described above[19]. The UK Government issued a consultation paper in June 2003 on proposals to amend the Waste Management Licensing Regulations 1994 (as amended). The Regulations were amended in 2005, with the spreading of gypsum waste to land included as an exemption.

Under the Waste Management Licensing Amendment (Scotland) Regulations 2004, the spreading of gypsum waste to land is no longer an exempt activity. This is because the proposed Waste Acceptance Criteria, which has been approved as part of the Landfill Directive (see Briefing Note BNPB3), defines gypsum as a non-inert material. Furthermore, there are concerns that gypsum can cause environmental problems when mixed with biodegradable material.

Gypsum is being used for land application in the UK. The use of recovered gypsum from post-consumer plasterboard, however, is still a novel idea, although it is common practice in North America, where plasterboard is banned from landfills in Canada. Agricultural applications account for 8% of all gypsum production in the USA[20]. Ground plasterboard waste typically has more potassium and magnesium than agricultural gypsum. It is commonly applied to peanut crops in the Southeast USA as a source of calcium at rates of 0.3 to 0.4 tonnes per acre. Many vegetables, including potatoes and corn, have been shown to benefit from gypsum application. In Michigan, USA, plasterboard exemption can be applied for and obtained from the Department of Environmental Quality. This allows plasterboard waste from new-build projects to be processed for land application and act as a modifier to compost[21]. So far, two companies in the UK are known to be using plasterboard waste for land application. Their names cannot be disclosed owing to commercial confidentiality. Anyone interested in using plasterboard waste for soil amendment should contact the local EA for guidance.

4.2 Enrichment of compost

There are a few locations in the USA that are adding scrap plasterboard to their composting system. Many of these facilities do not focus solely on composting as an activity but carry out a combination of material recycling with composting activities. This concept could present a solution to the logistics barrier for recovery of plasterboard for recycling.

[19] Department for Environment, Food & Rural Affairs (Defra), Waste Strategy 2000 for England and Wales Part 1 & 2. Chapter 5 Waste management options, http://www.defra.gov.uk/environment/waste/strategy/cm4693/12.htm
[20] US Geological Survey. http://minerals.usgs.gov/minerals/pubs/commodity/gypsum/
[21] State of Michigan. http://www.deq.state.mi.us/documents/deq-whm-stsw-gypsumdrywallexemption.pdf

Gypsum will not biodegrade to any major extent. It can be viewed as indirect land application, with the gypsum incorporated into the final compost product to produce a calcium and sulphur rich soil.

A study[22] in the USA investigated the feasibility of recycling plasterboard waste as a bulking agent in the composting process. It was suggested that if a facility regularly receives high volumes of grass during one part of the season and does not have an adequate supply of woody bulking material to provide porosity, a mix supplemented with chipped plasterboard might be an appropriate measure to help prevent the generation of odours. The conclusions of the study showed no detrimental effects (aside from minor aesthetic issues) in the product or in the off-gases. In addition, gate fees can bring revenue to the site, aiding its economical viability. As with any feedstock, proportions greater than those recommended could diminish the quality of the product or the process balance so that composting does not occur or it is rendered unsuitable for use. The study showed that incorporating plasterboard waste can be beneficial to the composting process and will not affect the process or the product quality adversely if used in the proper proportions. The pH of the finished compost was well within the acceptable range for end use in most situations. All of the mixes trialled met the Environmental Protection Agency's (Environment Agency equivalent in the USA) pathogen reduction requirements. The end product contained more visible gypsum (whitish chalky powder) as the ratio of plasterboard in the initial mix was increased. The end use of the material is dependent upon the aesthetics and the desired organic content.

4.3 Recycling on construction sites

Although in-situ recycling of gypsum on site is not conducted in the UK, the Gypsum Association[23], based in Washington, DC, recommends it and gives guidance on procedures for disposal of job-site new construction waste gypsum board on residential building projects. The procedures are as follows:

1. Waste gypsum board to be disposed of on site should be pulverised so that all pieces on the soil surface, including paper, will disintegrate in a reasonable period of time under local precipitation levels and other climatic conditions. This suggestion generally means that all pieces of waste gypsum board, including paper, placed on a residential building lot will be equal to or smaller than one-half inch square or in diameter.
2. Pulverised waste gypsum board may be placed on the soil surface or mixed with the top layer of the soil.
3. Waste gypsum board should be spread evenly over the entire lot where conditions of terrain and landscaping considerations permit.
4. Application may be at rates up to the equivalent of 22 tons per acre.
5. Pulverised waste gypsum board should be disposed of only on lots or in areas that have adequate drainage and aeration (i.e. no standing water or anaerobic

[22] Composting of Clean Gypsum Wallboard Scraps (1997). Clean Washington Center. www.cwc.org

[23] Gypsum Association www.gypsum.org

conditions should exist until the waste gypsum board has completely disintegrated).

6. State, local and federal regulations and statutes should be considered so as to ensure compliance with all environmental and other governing ordinances and rules that allow these types of utilisation for waste gypsum board or if special permission is necessary to dispose of construction waste gypsum in this manner.

4.4 Cement

The typical gypsum content of Portland cement (OPC) ranges from 5 to 10% by weight. Crushed gypsum is mixed with cement/clinker in the manufacture of Portland cement. It acts as a retardant, controlling the setting time of cement. Gypsum also finds use in cementitious formulations with non-OPC products, such as the manufacture of high alumina cement, super sulphated cement etc. The biggest challenge to using recovered gypsum in cement is the purity of gypsum in the wallboard and the paper content. Mined gypsum rock is often used by cement kilns. The different physical form of processed plasterboard may necessitate adjustment of the facility's materials handling system. Paper should be removed, and care should be taken during the collection of the plasterboard to minimise the amount of impurities, such as soil, that are introduced. Cement plants may be interested in trialling recovered gypsum if the paper content is 1% or less. This is a specification which current reprocessors are already able to meet. Cement production accounted for 13.5% of total gypsum products produced in the USA[24] which renders it a potentially feasible and viable end market for recovered gypsum in the UK, making more research and trials worthwhile.

5 Barriers to greater end-of-life resource efficiency

Stakeholders from the supply chain including manufacturers, waste producers, waste managers and federations/associations were contacted to discuss barriers to greater end-of-life resource efficiency. Barriers discussed are as follows.

5.1 Legislation

A footnote on the Environment Agency's (EA) Landfill Directive Regulatory Guidance Note 1, on the landfill disposal of non-hazardous waste with high sulphate or gypsum content states that "The Agency considers that gypsum based and other high sulphate bearing materials related to both gypsum and other forms of sulphate containing waste with a content of more than 10% sulphate per load" need to be disposed in dedicated cells. Waste producers (ie construction contractors) have therefore continued to dispose of plasterboard in a container as long as it does not exceed 10% of the load. The bulk of plasterboard waste is produced during 'first fix', and skip contents at this time may mostly comprise plasterboard waste. Waste transfer stations have suggested to clients that they will receive 100% plasterboard skip loads as these will be mixed with other wastes at the waste transfer facility. The

[24] US Geological Survey. http://minerals.usgs.gov/minerals/pubs/commodity/gypsum/

amount of plasterboard present in a container arriving at a landfill will be diluted such that it would never surpass the 10% threshold figure.

Since the implementation of the Waste Acceptance Criteria (WAC) on 16 July 2005, there has been a flurry of activity from industry to help it adapt, with economic profits in mind. Business opportunities for recycling/reprocessing plasterboard have been explored. Evidence of this includes: the number of recycling/reprocessing facilities currently existing as opposed to none/unknown a year ago, more dialogue and enquiries about end markets (eg land application), increased number of stakeholders, WRAP including plasterboard into its programme and more contractors enquiring about plasterboard recycling opportunities. Since the introduction of the 10% allowance threshold, a reduction in activities (measured as enquiries from contractors) was apparent. Enthusiasm about recycling/reprocessing has subsequently dipped. It is believed that most contractors (other than a few large main contractors) are currently mixing plasterboard waste with other waste to the 10% allowance as far as possible[25]. Waste managers and reprocessors are currently very dissatisfied with this 10% allowance, as they believe it is hindering them from making plasterboard recycling a viable business. This is confirmed through stakeholder (recyclers/reprocessors) discussions; the main barrier brought up by all waste producers and waste managers is the 10% allowance.

It is known that the EA has had complaints from waste producers and managers about implementing policies and regulations which have no immediate solutions. The opinion from stakeholders consulted is that the EA is obstructing the development of reprocessing infrastructure. Legislation that is unclear and which has not allowed industry sufficient time to understand and implement it properly has had a negative impact on industry. With limited resources to police the regulations and without adequate recycling facilities available, the EA has given waste producers too much leeway whilst the infrastructure is being created and thus hindered progress, even causing a decline in the recycling infrastructure being built. With some contractors, the incentive to segregate plasterboard waste has been removed, making it more difficult for waste managers to promote their services.

Note that for Scotland, with no plasterboard manufacturers or recycling facilities, the Scottish Environment Protection Agency (SEPA) has not provided such a footnote. It allows a limited mixture.

5.2 Material contamination

5.2.1 Demolition and refurbishment plasterboard waste

Demolition and refurbishment plasterboard waste, which is being recovered for recycling in North America and Scandinavia, is considered too contaminated (eg with screws, glues, timber, paint, wallpaper etc) to be recovered for recycling in the UK (and economically unviable). All of the plasterboard generated during demolition and refurbishment projects is waste. Plasterboard Recycling UK (PBR:UK) is currently in discussions with a major demolition company to trial the recovery of plasterboard waste from demolition projects, with agreement that any contaminated containers will

[25] Stakeholder communication.

be sent back or landfilled at the expense of the company. The plasterboard recycling facilities in Bristol and Immingham, run by New West Gypsum for Lafarge and Knauf, claim their North American technology is able to handle demolition and refurbishment plasterboard as long as the plasterboard is still identifiable as plasterboard. Gypsum Recycling International claims that its mobile equipment from Denmark is capable of handling demolition and refurbishment plasterboard waste, and so GRUK (the UK division) has the capability to do this in the UK. Both technologies have proved to be able to handle demolition and refurbishment plasterboard, with common contaminants such as paint, wallpaper, screws etc not being an issue. So far, these companies have not been reported to be receiving such waste. A possible explanation could be the manufacturers' (the only end market currently) scepticism about the end product meeting specifications and the economics of recovery and reprocessing. WRAP is currently funding a mosquito fleet collection trial for strip-out waste from sites in London to determine the viability of this system in the UK.

More problematic issues of contamination from demolition and refurbishment plasterboard waste concern lead-based paints. Although lead-based paint has been banned since the 1970s, plasterboard waste generated during demolition and refurbishment of structures from that era could be contaminated with lead-based paint. This may not be a difficult issue for the recycling and recovery of gypsum as many kits are available for lead testing, where a simple colour change indicates the presence of lead. According to New West Gypsum, whose end product has undergone many such tests, the presence of lead has not been detected. This may be due to the small volume of such waste being generated, and the dilution of the waste with cleaner plasterboard offcuts from new-build projects. PBR:UK specifies that no lead-based backing is accepted.

The end markets most likely to be affected by lead-based paint are direct landspreading of the product and composting. These end markets will be most affected by trace metal contamination limits.

5.2.2 Source segregation

Plasterboard waste contamination is not necessarily physical contamination of the plasterboard. It also occurs due to a lack of segregation at source, by construction and demolition contractors, where containers and skips are contaminated by mixed waste. This culture of mixing waste products causes problems for the segregation of any types of material for recycling. Guidelines assisting the industry to separate at source or mandatory requirements for certain waste streams, along with company guidance to on-site staff, could be beneficial.

Segregation at source is slightly more complicated for the demolition sector as deconstruction and segregation of plasterboard is not currently common practice. The removal of partition stud walls (plasterboard included) is usually conducted mechanically. Mechanical segregation will potentially generate plasterboard material contaminated by adjoining materials (eg timber). Manual segregation that generates cleaner materials for recycling will result in higher staff costs, lengthier project durations, health and safety issues etc, all of which contribute to extra costs. Although it is also time and labour consuming to deconstruct office buildings manually, plasterboard from the refurbishment of office buildings will be easier to

deconstruct manually than that from housing. These projects potentially generate larger pieces of plasterboard suitable for re-use.

5.2.3 Fire-retardant plasterboards [26] [27]

Fire retardant plasterboards contain a small amount of fibreglass; the fibres help to hold the drywall together during a fire. The agronomic effects of using normal plasterboard on agricultural fields have been fairly well documented in the USA. US research is currently focused on the impacts of applying plasterboard containing fibreglass to the biological community on agricultural fields. Approval was given by the Department of Natural Resources (DNR) to conduct a six-week study using the USDA and the US Composting Council approved standard method for soil testing, called The Earthworm Subchronic Toxicity Test. The study conducted used a representative species of earthworms. They were monitored over time for any detrimental effects, such as mortality or weight loss, that may be attributed to the introduction of plasterboard containing fibreglass.

Results indicated that even at high application rates of the plasterboard, there was no significant effect of the plasterboard on the earthworms. There was no decrease in the number of worms, activity level remained high, and worm weight decreased evenly in all of the worms. Based on these results, the DNR approved the land application of plasterboard with fibreglass content from the construction site of Alliant Energy's worldwide corporate headquarters.

The impact on human health is another concern with regards to fibreglass content in plasterboard. Fibres are considered too large to pose an inhalation health hazard but the impacts after grinding and crushing them into smaller particles remain uninvestigated.

5.3 Technology

Currently, technologies and equipment for processing plasterboard waste in the UK have come from North America and Scandinavia. These technologies and equipment are prohibitively expensive to purchase, although Gypsum Recycling International's (GRI) mobile equipment service can be rented/leased. An English company, known to BRE, is working on developing equipment that is less expensive.

There are different processing methods for plasterboard recycling. The two major objectives of processing are separation of gypsum from the paper and size reduction of the gypsum itself. Dust generation is a significant issue associated with plasterboard processing, and is addressed by indoor processing and by minimising emissions by misting the air with water.

The Canadian New West Gypsum Recycling (NWGR) process, described below, is an example of how plasterboard can be processed:[28]

[26] Department of Natural Resources http://dnr.wi.gov/org/caer/cea/assistance/construction/index.htm

[27] Wolkowski, R and Crosby, A (2001). Sensitivity of Earthworms to Type X Gypsum Drywall under Controlled Environmental Conditions. Department of Soil Science. University of Wisconsin-Madison.

[28] New West Gypsum. http://www.nwgypsum.com/english/rp_01.htm

1. In-bound wet and dry loads of waste product are delivered to the NWGR plant's tipping floor, and hand-cleaned of metal, plastic and other debris.
2. The raw material gypsum waste is loaded into a large feed hopper and then fed onto a conveyor belt, where an electromagnet removes ferrous metal fragments.
3. The material is then conveyed to an enclosed processing area that separates the paper liner from the gypsum core.
4. The recyclable gypsum is taken back to plasterboard manufacturers, where it is combined with virgin rock or synthetic gypsum to make new plasterboard.
5. The paper is further processed prior to recycling for use in a wide variety of applications.

The recycling process will typically remove larger contaminants and metals before entering self-contained plasterboard processing equipment. Many of these operate using grinders/shredders followed by a screening system (eg trommels for segregating paper) and a dust collection system. Standard size reduction machinery has been used at many waste processing sites to process plasterboard in North America. These need to address the issue of dust and will normally need to carry out screening too. A recent development in reprocessing is the use of small grinders at the construction site; the idea being to apply size-reduced gypsum directly at the site.

NWGR is able to process wet products which certain other technologies cannot. An argument used to justify the idea that the ability to process wet waste is not required is that by insisting contractors store their plasterboard in sheltered areas or skips with lids, contractors do not incur the costs of hauling 20% - 30% water content in the waste to the processing facility[29].

Currently, there is no known technology able to combat the problem of dust. Dust is a processing and health and safety issue. Inhalation of gypsum might not be harmful to health but it creates a difficult working environment. Technologies and production methods to alleviate the dust issue should be investigated. This would create a better and safer workplace through better handling of the product.

Specifications for end products are dependent on end markets. A barrier to incorporating recovered gypsum back into new plasterboard is the amount of residual paper on the recovered gypsum. The 5% paper content of plasterboard has to be reduced to less than 1% to be incorporated back into the production of new boards. Size reduction is another barrier, as it is costly and time-consuming to adapt equipment to produce specified sizes required for different end markets.

5.4 End markets

The current end market for recovered gypsum is its inclusion in the manufacture of plasterboard. This limits the opportunities to divert plasterboard waste from landfill. Current plasterboard recyclers, with the exception of PBR:UK and Roy Hatfield, are

[29] Personal communications with stakeholders.

located adjacent to plasterboard manufacturers, relying on them incorporating recovered gypsum back into their manufacturing process. There are only three such manufacturers in the UK. Recyclers (with mobile or stationary equipment) are normally situated in close proximity to manufacturing plants, except for British Gypsum (BG) which has its own in-house recycling. This arrangement reduces haulage (a large proportion of the cost) for the manufacturers, making it more worthwhile for them to use recovered gypsum. Having a limited number of plants significantly hampers the opportunities for plasterboard recycling, as haulage distances for plasterboard are long, making it less economically feasible. BG offers a take-back scheme for its own boards from housing and commercial projects; it is reserved for special contracts excluding smaller projects and companies. Lafarge Plasterboard offers a scheme for its own customers, and housing and commercial projects, and New West Gypsum offers a solution to the wider industry utilising its plant based at Lafarge Plasterboard in Bristol.

With only one end market, increasing the level of plasterboard recycling is severely hindered. The Waste & Resources Action Programme (WRAP), specialising in the creation of end markets, has included gypsum as a material stream in its programme. The three-year programme could increase the range of possible end uses for recovered gypsum and accelerate progress in this area.

There is also a company in Yorkshire specialising in all types of industrial waste. It has been recycling gypsum plaster moulds, which is still a relatively small market, and is currently moving into plaster fines and plasterboard. This company, like other stakeholders, are currently actively seeking alternative and new end markets. As the focus on plasterboard waste intensifies, competitiveness in business will increase, including commercial confidentiality. This can act as a catalyst and a driver to recovering plasterboard waste for recycling. Common ‘new’ end markets recur: cement production, soil enhancer and moisture/odour/oil absorption applications such as cat litter and animal bedding. One stakeholder was adapting its equipment to meet the specifications of a newly discovered end market.

5.5 Logistics

PBR:UK charges £110 per tonne for the provision of a 40-yard skip and haulage in the Glasgow and Edinburgh area and is currently the only company known to offer plasterboard recycling in Scotland. This situation is the result of there being no plasterboard manufacturers in Scotland, therefore the plasterboard has to be hauled back to England, comprising the bulk of the cost. Owing to the lack of infrastructure (eg end markets and facilities), logistics for collection will remain a huge barrier to increased recycling levels. Currently, even within England, the distance between reprocessors is vast. Facilities currently available in Bristol, Immingham and Sittingbourne operate in liaison with plasterboard manufacturers. The facilities do not provide haulage and charge about £25/tonne gate fee for plasterboard waste. Some arrangements have been agreed with waste managers to provide skip and haulage services. A cost of around £80/ tonne has been indicated for the collection, transportation and reprocessing of waste plasterboard. Collection depots located all over the UK are available to bulk store plasterboard waste for processing. In summary, current and potential collection systems include the following:

- Hauled by the contractor generating the waste.
  The contractor generating the waste may be willing to haul the waste if there is an economic incentive.
  Reverse logistics. Back-hauling may be an incentive for the contractor to return recyclable or re-usable drywall scrap. In other words, the contractors could pick up new plasterboard and drop off plasterboard waste at the same time and place.
  The contractor's willingness to haul waste may decrease if the haulage location changes constantly (directly to site) or has inconvenient hours.
- Hauled by the waste processor. It may be economically viable for the processor accepting the plasterboard waste to haul the material if there is a consistent supply of material, it meets their specifications, the end product is in high demand, or if the processor has developed the infrastructure necessary to support collection.
  The party accepting the discarded plasterboard waste may be willing to haul the waste if they can use waste facilities (ie waste transfer stations as bulking stations to make it economically feasible).
- Hauled by a third party contracted to transport the plasterboard between sites. Companies with existing haulage infrastructure in place could undertake this.
  The third party's fee must be such that neither the contractor nor the processor can haul the material for a lower cost. The third party's fee must also be equal or less than the cost of general waste disposal. The plasterboard waste may also be brought to a central transfer station by a local haulier or the contractor and then transported from there by the receiving organisation. This option provides the opportunity for a variety of secondary uses.

5.6 Lack of plasterboard waste generation data (especially from demolition and refurbishment projects)

The basis for sustainable (environmentally, economically and socially viable) management of any waste stream requires an understanding of the volumes generated. Measurements must be made before any process management can be effective on and off site. There are very limited data available on plasterboard waste generation beyond anecdotal evidence and ad hoc projects. Figures from different sectors of the industry are being quoted with little evidence base. The figures on product sales will contribute to waste generation figures but will not provide the whole picture, as demolition activity is not directly related to sales and will produce varied volumes of waste according to different projects (eg construction type, project type).

Waste in mixed skips is not often measured, and there is little information on the percentage constitution of plasterboard. Consequently, the task of ascertaining demolition and refurbishment waste arisings with much confidence has not been possible.

Industry and stakeholders along the supply chain have identified the lack of plasterboard waste data as a barrier to better waste management of the material. It

is felt that they could benefit from having data on waste arisings. This is important as it allows resource planning:

- Policymakers – require the evidence base to include plasterboard as a priority waste stream.
- Plasterboard manufacturers – require data to plan resources (eg raw material substitution/capacity/absorption, service infrastructure etc).
- Waste managers – the data will need to be used to feed into business plans to investigate economic viability.

Related MTP information

- BNPB1: Plasterboard - Industry, Product and Market Overview
- BNPB3: Plasterboard - Legislation and Policy Drivers

Changes from version 1.0

Editorial changes were made following an internal review

Consultation and further information

Stakeholders are encouraged to review this document and provide suggestions that may improve the quality of information provided, email **info@mtprog.com** quoting the document reference, or call the MTP enquiry line on +44 (0) 845 600 8951.

For further information on related issues visit **www.mtprog.com**