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The building stock is facing a renovation wave - Insulation materials must open up the material cycle

Der Gebäudebestand steht vor einer Sanierungswelle – Dämmstoffe müssen sich den Materialkreislauf erschließen

Endbericht

Forschungsprojekt, gefördert von der Deutschen Bundesstiftung Umwelt (AZ 34426_02-25) DBU
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6.1.3 Material Recycling via PolyStyreneLoop (PSLoop)

Material Recycling continues to be possible by means of the solvent-based CreaSolv® Process which has been in test operation at a plant in the Netherlands since July 2021. Here, the EPS plastic is selectively dissolved via a solvent formulation and then precipitated again. It can then be used as polystyrene regranulate (R-GPPS) after extrusion. Insoluble impurities and those dissolved in the solvent mixture can be separated. The flame retardant HBCD, which previously made it impossible to recycle EPS insulation boards produced before 2016, is also separated in this way. (PSLoop 2020) Since the polystyrene is recovered in its own form, the CreaSolv® Process is not a chemical recycling process, according to industry classification, but a physical recycling process, which can be classified as Material Reycling (Schlummer et al. 2020). This also allows a higher degree of purity to be achieved in the R-GPPS.

Required material properties for recirculation:

According to the published access criteria, the total amount of impurities in the insulation materials must be ≤ 7 wt% (van Dijk and Reichenecker 2020). It should be noted here, that the EPS material is very light and the required amount is quickly exceeded, if mineral adhesions are involved. Also, the HBCD content must not exceed 1.5 wt.%. (van Dijk and Reichenecker 2020).

6.1.3.1 Processing & Sorting | Collection & Collection

PS Loop has so-called collection hubs in Germany (currently 3) (IVH 2021). These are responsible for both logistics and the required quality. The main task of these hubs is the bundling and compacting, which can also be performed by sorters. This is done using both stationary and mobile equipment. Suitable technology for pre-treatment, such as air classifiers, is not yet available, but are planned for the future, if the process can be operated in a technically stable and economical way. The collection hubs will be operated by existing waste management companies, which have the necessary permits. For HBCD-containing material, the costs of transport and collection associated with the recycling law are significantly higher. The storage is subject to notification; the areas are subject to requirements for fastening, water drainage and roofing (HUB 2021).
Currently, only clean insulation materials from the deconstruction of flat roofs are accepted by the hubs (HUB 2021).
Due to compaction, logistics are currently economical. According to the collection hub operators, the energetic waste incinerators in metropolitan areas in particular are currently working at full capacity and are charging high prices for the disposal of EPS containing HBCD. According to one HUB it is economically more attractive to compact the material on site in Berlin and ship it to the Netherlands than to incinerate it in the nearest possible incineration plant.

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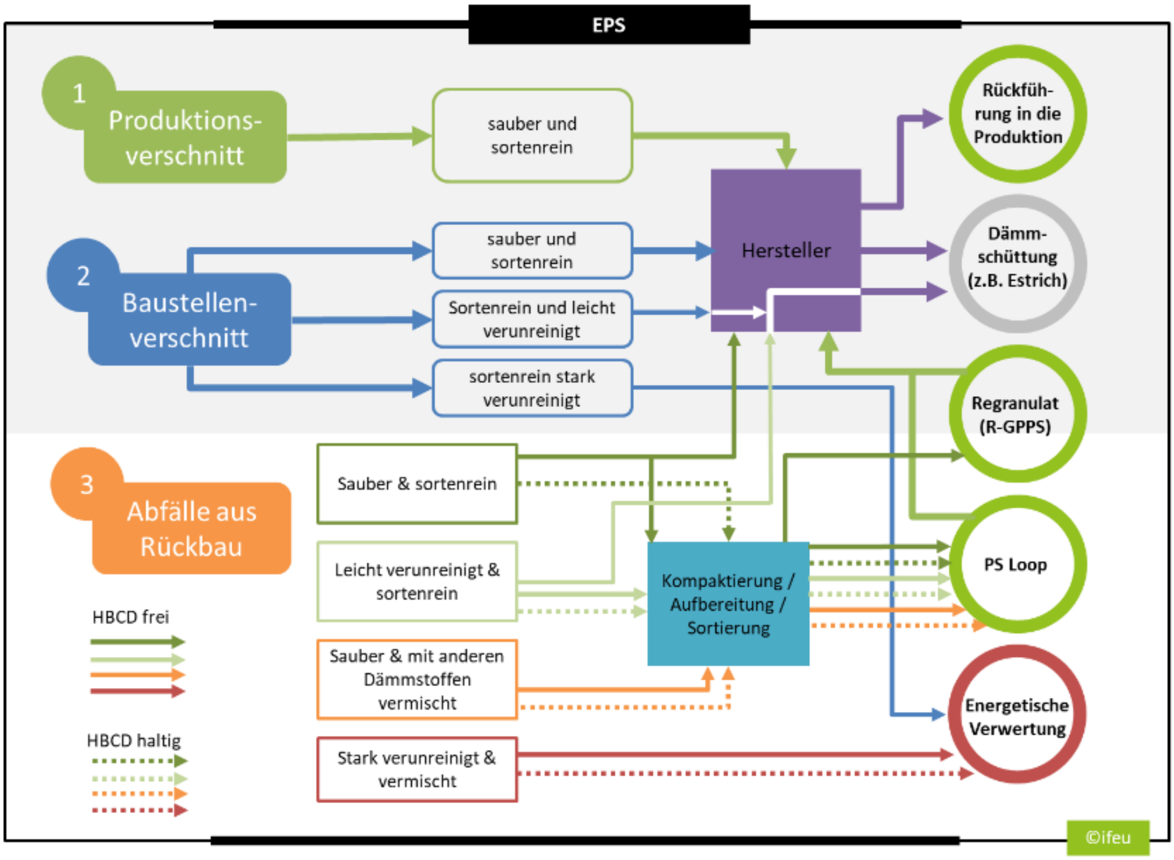

Figure 6-1: Possible current (fraction 1 and 2) and perspective (fraction 3) disposal routes of EPS insulation materials

6.2 Extrudiertes Polystyrol (XPS)

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6.2.2 Material Recycling via PolyStyreneLoop

Since XPS, like EPS, consists of the basic material PS, XPS can also be recycled in the Dutch PSLoop plant by the physical solvent-based process and processed into R-GPPS. At the time of the research, the plant was in a start-up operation that has been running since July 2021. Initially, only the recycling of EPS is envisaged. If the process becomes established, the industry expects to recycle in the future be able to dispose of post-consumer XPS via this route (FPX 2021; IVH 2021; XPS 2021). Further information on how the process works can be found in section 6.1.3 above.

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9.2 Disposal Routes for Synthetic Insulation Materials

Figure 9-6 shows the results for insulation boards made of EPS, as described in the chapter above.

Thermal treatment in a waste incineration plant or in a cement plant leads to corresponding greenhouse gas loads in the "waste disposal and thermal" sector due to the release of the carbon in the EPS as carbon dioxide. EPS is produced from petroleum; thus it is fossil carbon that should not be released into the atmosphere. The acidification potential shows that the combustion process causes emissions of NOx, among other things. Due to the better flue gas cleaning, the loads of the waste incineration plant in this respect are lower than those of the cement plant. Material Recycling via PolyStyreneLoop (PSLoop) leads to burdens in the sector "material recovery", which result from the provision of, in particular, electricity and process heat for the PSLoop process (solvent-based material recycling).

On the other hand, the thermal disposal in the waste incineration plant creates a relief through energy generated in the process in the form of electricity and heat, which substitute the same amount of German grid electricity mix or heat from gas boilers in domestic heating systems with their loads. Due to the relatively low energy efficiencies of the waste incineration plants, the reductions are moderate. In the cement plant, process heat is generated by burning the high-calorific EPS, which currently still substitutes for heat from hard coal, the standard fuel otherwise used there. This currently results in correspondingly high discharges. Material recycling recovers and reuses polystyrene, which can replace primary polystyrene, the production of which is associated with relatively high loads.

In net terms, there is a clear advantage for material recycling via PSLoop across all impact categories/indicators considered. Disposal in the waste incineration plant is associated with a load in the greenhouse effect, because the fossil carbon dioxide emissions cannot be offset by the relief achieved via the generated energy. Normalization shows that the relief in terrestrial eutrophication potential is the smallest and is otherwise relatively similar when comparing the other impact categories. A clear difference in quantitative significance cannot be derived from this. **It can be seen that a material assessment of synthetic insulation materials is particularly urgent from an ecological point of view.**

English Translation

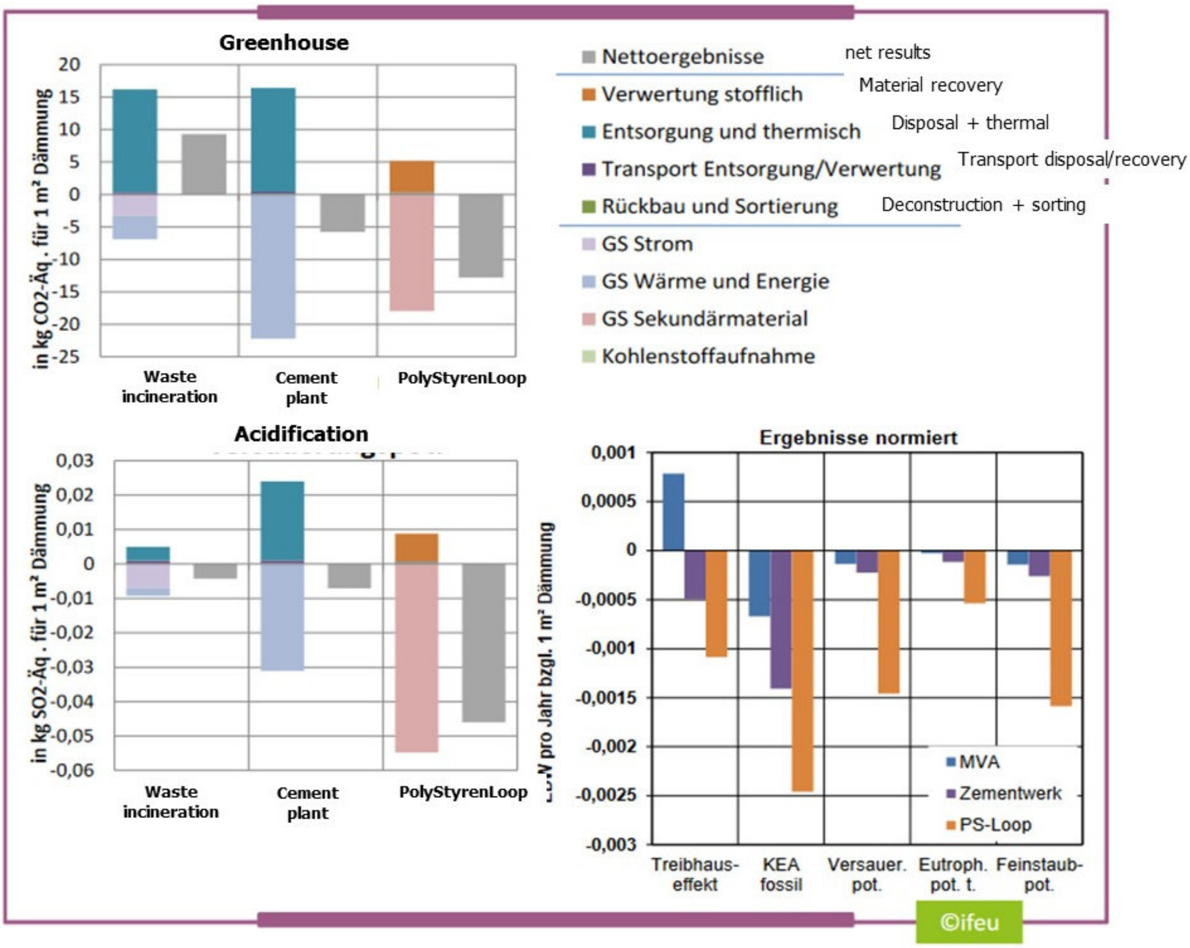

Figure 9-6: Ecological evaluation of the now already possible disposal routes of EPS insulation boards according to the greenhouse effect, acidification potential and the net results normalized to inhabitant average values of all considered impact categories/indicators.

English Translation

Figure 9-7 shows the reductions in greenhouse gas emissions resulting from the reuse of EPS boards of the EPS panels are shown next to disposal in the waste incineration plant and material recycling via PSLoop. **Even more relief is achieved by reuse than by material recycling** ***(what is only an option, if EPS does not contain HBCD!).*** However, since the production of polystyrene, which can be substituted by material recycling, already bears a significant share of the burden of EPS insulation board production, the additional relief is not as large as for mineral insulation materials or insulation materials from renewable raw materials. In the case of the latter, only small shares of the production loads of the respective insulation materials are saved by returning them to production as a material recycling route, as described there.

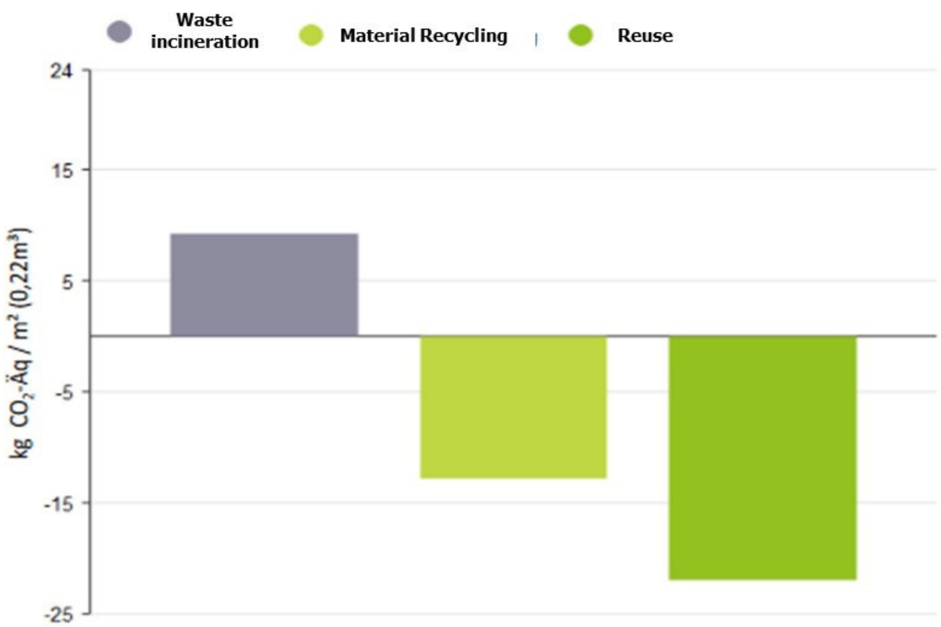

Figure 9-7: Net results in greenhouse effect for disposal routes vs. reuse of EPS insulation boards.

A very similar pattern is emerging for XPS as for EPS. The same disposal routes are available. The calorific value and composition of XPS differs only little from EPS. The amount of XPS insulation installed per 1 m² is larger, in particular due to the higher density, which is why the absolute figures for loads and reliefs are correspondingly different. But this does not change the pattern, which is decisive for the evaluation of the disposal paths. Therefore, reference is made at this point to the explanations for EPS can be referred to.