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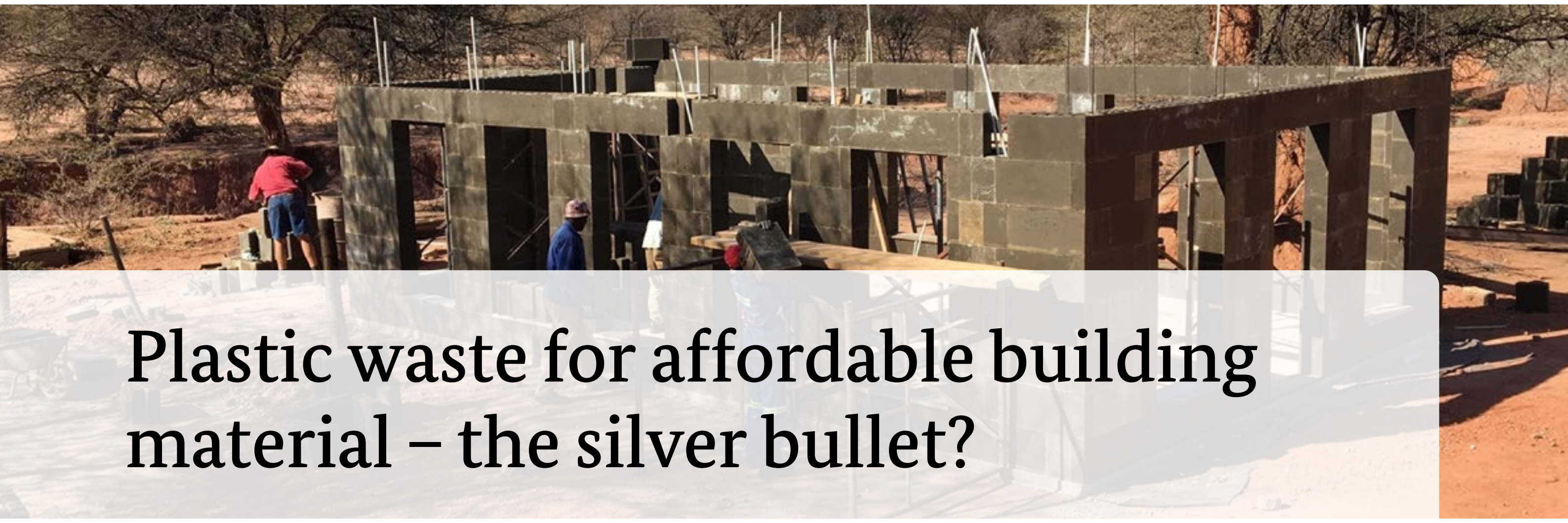

Plastic waste for affordable building material – the silver bullet?

Background and challenges

Plastic is one of the most used materials for consumer goods, packaging and as building material. The **use of plastics in the building sector** is greatly influenced by current megatrends: climate change, pollution, demography and urbanisation, need for resilience, health, as well as affordable housing and shelter with its regional implications.

Affordable housing is a global challenge in both emerging and advanced economies, where more than 1.8 billion people around the world lack decent housing (UN-Habitat, 2021).[1] The **affordable housing gap** worldwide is estimated at 330 million urban households and predicted to increase to 440 million households, or 1.6 billion people, by 2025 (King et al. 2017).[2] Various organisations are supporting efforts to realise the Human Right to Adequate Housing[3], which is necessary for the **three pillars of sustainability**: economic viability, environmental protection and social equity.

In 2050, almost ten billion people are expected to inhabit the globe. More than two thirds of them will live in urban areas. This **surge in urbanisation is taking place almost exclusively in Africa and Asia**. What has developed in Europe over centuries is happening on these continents in the space of just a few decades. Rapid urban growth also means that by 2030 there will be more than 40 megacities with over ten million inhabitants.[4]

Plastic waste poses severe threats to the environment and humans as it continues to increase in volume, causing harm to terrestrial and aquatic ecosystems. One major source of pollution comes from single-use plastic and disposables, which are widely used in commerce and catering. Especially in countries with no functioning waste management system, lightweight plastic waste scatters everywhere without treatment. Incentives for separate collection and sorting of plastics, especially of packaging materials, can be difficult because there is limited market demand for secondary plastics (recycled plastics). This is above all true for mixed and low-grade plastic with low or **no value on the recycling market**.

? Could the use of **plastic as a raw material for the production of construction material**, especially for low-cost housing and shelters, give **plastic waste a second life**?

Using **more sustainable and recyclable materials in the construction industry** is also essential for the future reduction of greenhouse gas emissions. To support the achievement of global climate goals, a careful environmental life cycle assessment of available construction materials needs to be conducted, including recently hyped solutions based on virgin polymers, post-industrial and post-consumer plastic waste.

1 Housing Rights | UN-Habitat (unhabitat.org)
2 King R., Orloff M., Virsilas T. and Pande T. (2017). Confronting the Urban Housing Crisis in the Global South: Adequate, Secure, and Affordable Housing. Working Paper. Washington, DC: World Resources Institute. https://files.wri.org/s3fs-public/towards-more-equal-city-confronting-urban-housing-crisis-global-south.pdf
3 Housing Rights | UN-Habitat (unhabitat.org)

4 ISC3 Workstream Report: Sustainable Building and Living. Focus on Plastics. (2020) https://www.isc3.org/en/activities/collaboration/foresight-workstreams.html

Is plastic waste the building material of the future? – There is a lot to consider!

Affordable solutions are at hand for many categories of building materials

Available solutions on the market

A range of innovative approaches have been developed and placed on the market in response to the demand for affordable housing and shelters, using locally available plastic waste and therefore converting waste into a resource.

Based on limited or no pre-processing of mixed waste plastics combinded with locally available material:

- **BOXS AG** offers simple room solutions and shelter systems built with recycling boards made of plastic waste (BOXShelter in Jordan: **TADWEER project**).

- **TGSeed UG** produces smart wood by transforming plastic waste and farm residues into synthetic wood composites that can be processed into almost any shape (target market: Kenya).

- **Development Inc.** offers its patented Rejects of Glass & Plastic (ROGP) technology for recycling plastic and glass waste into a durable material composite with numerous applications in various industries (projects in Lebanon and Jordan).

Based on intensive processing of waste plastic or use of virgin polymers:

- **Polycare** produces "Polyblocks" made of virgin polymer and near-virgin-grade recycled PET bottles mixed with locally available mineral materials.

- The **Creasolv Process** makes it possible to separate mixed plastics, remove contaminants and deliver high-purity materials (near-virgin plastics).

Critical discussion of potential solutions

On the positive side, the conversion of locally available plastic waste into building materials for affordable housing and shelters could:

- Give **value to low-grade plastics** collected by waste pickers and hence
- **Generate income**
- **Reduce dumping** and/or littering of lightweight materials. Through this, pollution of terrestrial and aquatic ecosystems could be reduced
- **Replace the use of construction materials damaging to the environment**, such as concrete and steel, and materials that are expensive due to their long transport routes, such as timber, by affordable prefabricated construction material

However, adverse effects might occur, such as:

- Human **health risks** due to chemical compounds that might pollute indoor air quality
- Weathering and degradation as well as wear and tear that might generate **microplastic**
- Incorrect disposal of construction material at the end of its life cycle that might make **recovery difficult** or even impossible
- Mixing of a variety of plastic types as well as mixing of natural and inorganic material that might make **recycling impossible**
- Risk of no **social acceptance**

Plastics can play a major role in sustainable development if managed well

What strategies can help to overcome the shortcomings?

Existing initiatives are promising but not yet reproducible on an industrial scale. The manufacturing of prefabricated construction materials from plastic waste could serve as a bridging technology when other recycling options are economically unfeasible or not in place. With the introduction of a local market for low-grade plastic material, the use of plastic waste as construction material could encourage waste collection and generate local employment. Following an analysis of the strengths and weaknesses of the solutions available, combined with the threats and opportunities that the current environment offers, we developed strategies on how to advance towards sustainable yet affordable building materials:

EXPAND:

- **Research into new, safe and sustainable technologies** (modularity, durability, reparability, etc.) in order to be able to design healthier materials and ensure (more) circularity.
- **Incentives for investing in best practice**, though expensive recycling technologies to save resources. In this way, scarcity of minerals caused by urbanisation and the growing world population could be mitigated.
- **Worldwide implementation of fast solutions** possible due to the scalability of existing, affordable bridging technologies. As CO_2, raw material and refuse site prices rise, waste material prices will become competitive and could foster circularity.
- **Development of adequate leasing or product-service systems** (PSS). PSS offer temporary use of products without owning them. The service company usually continues to be the owner of the product and offers the use of the product as a service.

CATCH UP:

- **Starting with a well-planned design** to avoid hazardous impacts of materials and achieve high circularity rates. To achieve this aim, knowledge capacities need to be built.
- **Knowledge sharing on recycling technologies along with loans.** High investment cost for best practice recycling technologies will lead to a return on investment because raw material prices are on the rise.
- **Introduction of incentives and technical infrastructure to ensure material recovery** at the end of the building materials' life cycle (e.g. through take-back and deposit systems)
- **Collect data on all substances in a plastic composite** and possible re-use / recyclability of materials and make them transparent in a construction passport.

SAFEGUARD:

- **Indoor air monitoring,** including long-term measurement, in order to protect residents' health and future generations along with threshold values for use of plastic building materials. In addition, microplastic emissions into the environment need to be investigated and means found to avoid them.
- **By awareness raising** – e.g. capacity building for the informal building sector and visualisation of data on the contents of the building material (construction passport).
- **Through control mechanisms for the constant improvements** which are required (e.g. in cleaning technology or better separation), taking long-term environmental issues into account.
- **By introducing regulations** on recyclability alongside capacity building in order to avoid future legacies.

AVOID:

- **Limiting affordability to upfront project costs** but rather include both quantifiable and non-quantifiable latent costs such as health and environmental dimensions as well as costs at end of life.
- **Landfill after the first end of life.** Re-use / downgrading after first recycling should be taken into consideration.
- **Old-school, conservative building policies.** Openness towards new (safe) technologies and materials is required.
- **Uncontrolled and unconscious use of waste** (as is still normal practice). Mixing of unknown materials can cause negative effects on human health and the environment. Educated use is therefore key to more sustainable construction.

Building materials made from plastic waste can serve as bridging technology until other recycling options are feasible or available

The GIZ global project **"Support of the Export Initiative for Green Technologies"** aids Germany's Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) in its efforts to improve the enabling environment and develop markets for the introduction and application of innovative environmental technologies as well as the development of innovative green infrastructure in selected partner countries. It includes topics such as waste management, mitigation of air and water pollution or supporting infrastructures for sustainable urban development. Partner countries are Egypt, Jordan, India, Thailand, Malaysia, Indonesia and Ukraine. Project measures focus on building up technical and institutional know-how as well as laying the groundwork for the introduction and use of environmental and climate protection technologies "Made in Germany".

The **"International Sustainable Chemistry Collaborative Centre" (ISC3)** is a global institution and a multi-stakeholder platform operating on behalf of the BMU and the German Environment Agency (UBA). Hosted by the GIZ, ISC3 aims to shape the transformation of the chemical sector towards sustainable chemistry, thus contributing to the preservation of the environment and the establishment of a circular economy in order to meet the UN Sustainable Development Goals (SDGs). In 2021, ISC3 is starting its capacity-building programme for the construction sector in Kenya – focusing on sustainable (re-) use of plastics and circular economy. The workshop-based training is a joint approach with local partners in Nairobi: the Centre for Science & Technology Innovations (CSTI) and the National Construction Agency (NCA).

Both initiatives are looking to intensify their international outreach on the topic and seeking local and regional cooperation partners.

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