Plastic waste is the last straw, says UK

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Television programs rarely change thinking on materials policy let alone provoke new research initiatives. But that is exactly what happened in the wake of Sir David Attenborough's latest BBC TV series, *Blue Planet II*, which aired last fall. Among many images, these episodes—a follow-up to the first series broadcast in 2001—showed scenes of empty bottles and other plastic debris littering the seabed and the shorelines, and killing sea life.

The impact of these images in the UK, with front page coverage, prompting speeches from the Prime Minister, Theresa May, along with statements in Parliament by the Chancellor of the Exchequer (chief financial minister), with promises of policies to discourage the UK's use of single-use plastics. The most important move on research was the announcement of a new Plastics Research and Innovation Fund (PRIF).

The media interest also prompted businesses to jump in. Ikea, the global home furnishings retailer, announced that by October 2018, stores in the UK and Ireland would "no longer offer and sell single-use plastic straws." Fast food outlets such as McDonald's, which had already announced trials of paper straws, quickly followed suit.

The research focus was £20 million for the PRIF, managed by UK Research and Innovation (UKRI) and delivered through the Engineering and Physical Sciences Research Council (EPSRC), Innovate UK, and the Natural Environment Research Council (NERC). Science Minister Sam Gyimah said that the aim of the research will be "to come up with new technology and also new plastics that do not harm the environment so much."

A further impetus to quell the uncontrolled disposal of plastic waste came in a report last spring from the Organisation for Economic Co-operation and Development (OECD), *Improving Markets for Recycled Plastics* (doi:10.1787/9789264301016). This report put the failure to recycle some plastic down to the fact that it is still cheaper to make new plastic than to recycle plastic. The OECD highlighted several areas where research is needed, including chemical recycling, "technological processes that convert polymers into their constituent molecules, which can then be used as feedstock for new plastics, fuels or other petrochemicals."

One project in this area was the subject of a recent article in the *Journal of Cleaner Production* (doi:10.1016/j.jclepro.2018.03.205). Researchers at Aston University described work that created road surfacing material by the pyrolysis of "real municipal waste samples received from a local waste treatment plant" to create a material that they call bio-bitumen. The researchers believe that their research could add to the armory of recycling technologies. According to lead author Yang Yang, a researcher in biomass pyrolysis, "If the product is largely produced and widely applied, we would have a better way to convert our waste, including nonbiodegradable plastic waste, into a high-value construction material, instead of current disposal practices such as landfill and incineration—both of which are harmful to the environment."

Co-author Yuqing Zhang, a researcher in highway engineering, says, "Currently, we would need to blend our material into conventional bitumen for road applications such as asphalt, but ultimately our aim is to develop the product to replace it altogether." One objective of the "intermediate pyrolysis technology" is to incorporate a wide range of organic materials, including polymers that are now recycled in more conventional ways. According

https://doi.org/10.1557/mrs.2018.307 Published online by Cambridge University Press

to Zhang, "we expect to be able to significantly increase the proportion of the renewable parts, or the 'bio-fraction,' in the final asphalt mixture product for road surfacing." Highways England and the Birmingham City Council have already expressed interest in the work. For this to happen, industry will have to step in. That is the aim of the second part of the PRIF initiative, which will provide R&D funding for companies to bring new recycling technologies and new materials to market.

In a call last summer for projects under the banner "Plastics innovation: towards zero waste," the UK government set aside up to £4 million for companies "to develop new solutions to reduce persistent plastics entering our environment." The funding competition for this money could go to ideas for "developing new polymers, processes, designs, recycling regimes, value-added recyclate or bio-alternative."

In October, the UK's Business Secretary, Greg Clark, announced that 11 projects have won government backing of £4 million from the PRIF fund. The successful projects include, for example, one that will investigate recycling plastics such as for car bumpers and motorcycle helmets, which are currently sent to landfills, to turn them into plastic pellets for molding into new products. In another project, Skipping Rocks Lab in London will investigate the use of seaweed extract, already used as an alternative to plastic water bottles, to replace plastic packaging in single-use condiment sachets on takeaway counters. Another award was for a project to study biodegradable plastic packaging that can go into compost bins along with food waste.

The attack on plastics waste was the theme of yet another initiative unveiled by UKRI. The plan, launched by the Prime Minister at this year's Commonwealth Heads of Government Meeting in London in May, is to create a new global R&D hub to address this problem. India, Canada, and other Commonwealth countries have already agreed to be part of the new Marine Plastics Research and Innovation Framework, "a hub where researchers will be able to connect and collaborate on the latest research and innovations to tackle marine plastics."

Michael Kenward

Raw materials use to double by 2060 with severe environmental consequences www.oecd.org

The world's consumption of raw materials is set to nearly double by 2060 as the global economy continues to expand and living standards rise, placing twice the pressure on the environment than currently seen, according to a new Organisation for Economic Co-operation and Development (OECD) report.

A preview of *The Global Material Resources Outlook to 2060* released in October sees global materials use rising to 167 Gt in 2060 from 90 Gt currently, as the world population soars to 10 billion people and average global income per capita rises to converge with the current OECD level of USD$40,000.

Without concrete actions to address these challenges, the projected increase in the extraction and processing of raw materials such as biomass, fossil fuels, metals, and nonmetallic minerals is likely to worsen pollution of air, water, and soils and contribute significantly to climate change. The increase comes despite a shift from manufacturing to service industries and continual improvements in manufacturing efficiency, which has lessened the amount of resources consumed for each unit of gross domestic product (GDP). Without this, environmental pressures would be worse. The projection also takes account of flattening demand in China and other emerging economies as their infrastructure booms end.

The preview report, presented at the World Circular Economy Forum in Yokohama, Japan, by OECD Deputy Secretary-General Masamichi Kono, says the biggest rises in resource consumption will be in minerals, including construction materials and metals, particularly in fast-growing developing economies.

Nonmetallic minerals, such as sand, gravel, limestone, and crushed rock account for more than half of the total materials currently consumed in gigaton terms. Adding other materials, the total raw materials consumed by an average family in a day would fill up a bathtub. These volumes will only become larger between now and 2060.

The recycling industry, currently one-tenth the size of the mining sector in terms of GDP share, is likely to become more competitive and grow, but it will remain a much smaller industry than mining primary materials.

The report's global environmental impact analysis of the extraction and production of seven metals (iron, aluminum, copper, zinc, lead, nickel, and manganese) plus concrete, sand, and gravel shows significant impacts in areas like acidification, air and water pollution, climate change, energy demand, human health, and toxicity of water and land.

Within this group of metals and minerals, copper and nickel tend to have the greatest per-kilo environmental impacts, while iron, steel, and concrete have the highest absolute impacts due to the large volumes used.

The extraction and burning of fossil fuels and the production of iron, steel, and building materials are already major contributors to air pollution and greenhouse gas emissions. In the absence of new emissions-cutting policies, the report says overall emissions from materials management will grow from 28 Gt to 50 Gt of CO_2 equivalent by 2060. □

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https://doi.org/10.1557/mrs.2018.307 Published online by Cambridge University Press