CIRCULAR
ECONOMY
IN CITIES

MAKING MOBILITY SYSTEMS AND ASSETS USING NEW CONSTRUCTION AND MANUFACTURING TECHNIQUES

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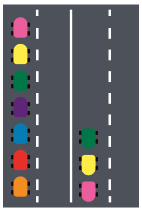
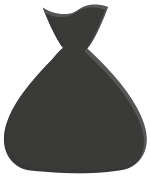
By incentivising and supporting new vehicle manufacturing and infrastructure construction techniques, cities can improve the use of resources and reduce traffic disruption. Vehicles and transport infrastructure account for significant material consumption and waste generation in cities. These negative impacts can be countered through circular economy actions that engage with infrastructure and vehicle manufacture.

CASE FOR CHANGE



13% of global resource consumption is related to mobility[1]



End-of-life vehicles constitute **8–9 million tonnes** of waste in the EU[2]

Road construction CO^2 emissions represent **5–10%** of total CO^2 emissions in the transport sector and are growing rapidly[3]

GBP 3 billion is spent by UK local authorities annually on highway construction and maintenance[4]

EXAMPLES OF CIRCULAR ECONOMY OPPORTUNITIES

Sourcing infrastructure materials strategically

Using recycled, alternative, and renewable materials in construction can boost the market for these materials and reduce virgin material demand. Ensuring that materials are reusable can eliminate landfill costs. In infrastructure projects, second generation material input is widely used. Recycled asphalt, and construction and demolition waste (CDW) used in infrastructure, has been proven to reduce construction costs while maintaining quality standards.[5] Using renewable materials such as bio-asphalt binders is also being explored; for example, using municipal organic by-products and pig manure as a substitute for traditional and more expensive fossil fuel-based asphalt binders such as bitumen.[6]

Manufacturing vehicles using resource effective techniques

Remanufacturing vehicles has the potential to create local jobs, reduce the demand for raw materials and energy, lower manufacturing costs, and close material loops.[7] Remanufacturing can be particularly promising in combination with vehicle-as-a-service models as these models incentivise prolonging the use of the assets.[8] Modular assembly and additive manufacturing of mobility assets can both increase the customisation of vehicles to a user's needs, reduce raw material requirements, and support the localisation of production which can in turn shorten the supply chain. These methods also reduce resource consumption in the manufacturing process.

Building infrastructure with new construction techniques

As with buildings, the construction of roads and bridges can be improved through new construction techniques that reduce waste and ease maintenance and repair. These include additive manufacturing, industrial construction, and building information modelling (BIM). For example, 3D printing of bridges offers a less disruptive and faster construction phase that uses fewer resources than conventional construction. Technology such as BIM can also support value chain collaboration, material tracking, and better material/component reuse down the line.[9] (See *Buildings: Making*)

RELEVANT CASE EXAMPLES

Saving road construction costs in Barnsley by using local materials

Barnsley Metropolitan Borough Council (UK) has saved GBP 13,500 by composting 450 tonnes of green waste each year and using it in highway schemes. It has saved a further GBP 60,000 in transport and landfill costs by recycling 95% of 'waste' highway materials.[10]

Locally printing and constructing mobility assets

Arevo Inc. in San Jose, California has developed a robot that can print an entire recyclable bike frame out of carbon fibre without the use of hazardous chemicals and without producing waste. The process allows a major part of the bike to be produced locally using significantly less time and energy than traditional manufacturing techniques. Due to machine affordability and the flexible nature of additive manufacturing, the business model is economically viable even with high levels of customisation and small-scale production.[11]

3D printing spare parts for trains

The Siemens Mobility RRX Rail Service Center in Dortmund runs an additive manufacturing process that reduces the time it takes to produce spare vehicle parts by 95%, while increasing the centre's self-sufficiency, and opening up more revenue streams by being able to service a greater number of low-volume orders cost-effectively and efficiently.[12]

EXAMPLES OF WHAT URBAN POLICYMAKERS CAN DO

Financial support can be an important lever when it comes to infrastructure development in cities, often in **partnership** with others. By implementing circular economy principles in **public procurement** specifications, city governments can also incentivise the use of new construction techniques and alternative, renewable, and reusable materials for roads, bridges, publicly owned vehicles, and vehicle fleets. Furthermore, by including mobility assets in waste reduction, reuse, and recycling targets in **roadmaps and strategies**, a city government can create long-term signals for the market.

To explore further see **Policy Levers**

EXAMPLES OF LINKS TO OTHER SYSTEMS AND PHASES

Mobility: Designing New construction and manufacturing techniques, and material choices, are often closely linked to decisions made in the design phase of vehicles and infrastructure. At the same time, design will need to be cognisant of new techniques.

EXAMPLES OF BENEFITS

ECONOMIC PRODUCTIVITY

Reducing construction time

Modular and offsite construction solutions helped save six months of construction time, reduce site labour by 30%, and minimise waste production on the A453 road widening project in the Midlands, UK.[13]

Reducing manufacturing time and stocks of spare parts

Additive manufacturing can reduce spare part production time by 95% and eliminate the need to stock up on spare parts as companies can print these in-house.[14]

Saving vehicle material costs

Remanufactured vehicle parts can be 30–50% less expensiveand still retain having the same levels of quality and guarantees as new parts made from virgin materials.[15]

Improving the business case while creating additional jobs and skills

While the cost of labour for remanufacturing vehicle parts may be a relatively higher share of the total production costs compared to linear manufacturing, it is typically more than offset by the relative reduction in materials, utilities, and other overheads and operating costs.[16]

JOBS, SKILLS, AND INNOVATION

Increasing skilled labour requirements

Remanufacturing of vehicle parts can increase skilled labour requirements by up to 120%.[17]

HEALTH AND ENVIRONMENT

Reducing emissions from road construction

Using recycled materials in road construction can reduce carbon emissions associated with asphalt roads by 37%, and by 28% in the case of concrete or brick roads.[18]

Minimising CO^2 emissions from vehicle parts

Remanufactured automotive engines could be produced with from 73% to 87% fewer CO^2 emissions than compared to traditional manufacturing of new engines.[19]

Minimising emissions through remanufacturing

In Michelin's truck tyre retreading plant, an estimated 60 kg of CO^2 emission is avoided each time a tyre is retreaded.[20]

COMMUNITY AND SOCIAL PROSPERITY

Including new customer segments

Lower-priced, remanufactured vehicle product options make these products more accessible to lower-income customer segments, who might not have been able to purchase them previously.[21]

RESOURCE USE

Saving material input

3D printing, also known as additive manufacturing, of machine components can reduce resource use by up to 65%.[22]

Minimising virgin material used in tyres

In Michelin's truck tyre retreading plant, 85% of a worn-out tyre is reused, saving some 30 kg of rubber and 20 kg of steel per retreaded tyre.[23]

Minimising material and energy used for vehicle parts

The remanufacturing of automotive components yields up to 88% of material savings compared to using a new product, with an associated 56% lower energy requirement.[24]

Reducing natural resource demands

Renault's remanufacturing process uses 80% less energy and 88% less water compared to the production of new parts.[25]

Recycled materials reducing demand for fuel and virgin materials

The use of recycled materials on the Burntwood Bypass in Staffordshire, UK saved nearly 200,000 miles of lorry movements, equivalent to 128,000 litres of fuel – resulting in GBP 60,000 of financial savings.[26]

ENDNOTES

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