Implementing the circular economy in mobility

The circular economy can improve the transport system's environmental balance, with circular mobility allowing for greater mobility using fewer vehicles and more durable, easily repairable products.

In Austria, the transport sector contributes just around four per cent to the country's gross value added (GVA), yet it is responsible for 28 per cent of greenhouse gas emissions - around 50 per cent more greenhouse gases per capita than the EU average. Instead of decreasing, CO₂ emissions from transport have increased sharply in the past decades. In comparison to 1990 levels, they rose by 56 per cent in 2021. Over the same period, the building sector was able to reduce its CO₂ emissions by one third.

Transforming mobility into a circular economy

A circular economy aims to minimise resource consumption, waste generation, and the environmental impact of products by extending their life and intensifying their usage. A central component of the European Green Deal, the circular economy has been implemented into national strategies. Transforming the transport sector through the circular economy is a necessity in light of the excessive emissions of greenhouse gases and pollutants, as well as the consumption of raw materials, that transport entails.
Total annual material consumption in Austria weighs in at around 19 tonnes per capita, well above planetary boundaries, i.e. what can be sustainably regrown. The transport sector is responsible for a large part of this. The expansion of infrastructure as well as the production of vehicles is very resource-intensive. A climate-compatible transport system reduces not only the demand for energy, but also for resources.

**Designing vehicles that are durable and flexible**

The "9R framework" is central to the application of the circular economy in mobility. The first step here should be to reduce the number of vehicles, e.g., through sharing of vehicles as well as fostering a dense public transport network. The next step is to reduce the amount of material and energy consumption associated with vehicle production. Only when products or components can no longer be used elsewhere despite their extended service life are they added to the waste stream, used as secondary raw materials, and reintroduced into the material cycle. Only the waste which is not suitable for material recycling is thermally recycled.

**Reuse materials and resources**

The R strategies require that, when it comes to vehicle production, all opportunities for efficiency, durability, repairability, and the easy recovery of components and materials are exhausted even as early as the design phase. There is significant potential for savings in vehicle manufacturing by rethinking along circular economy principles.

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**The 9Rs of the circular economy to better mobility’s environmental balance**

1. **Refuse**
   Make things redundant. Products can become superfluous, such as when the path from A to B can be undertaken using public transport instead of an automobile.

2. **Rethink**
   Think anew. Use vehicles more efficiently and reduce their numbers through carsharing and ridesharing.

3. **Reduce**
   Reduce. Increase resource efficiency and reduce the use of materials by using more compact vehicles.

4. **Reuse**
   Reuse. Reuse components that are still functional.

5. **Repair**
   Repair. Inspect vehicles and their components and repair to use again.

6. **Refurbish**
   Refurbish. Fix or upgrade old vehicles and components to bring them up to meet the latest standards - including replacing an ICE engine with an electric motor.

7. **Remanufacture**
   Remake. Use parts from defective vehicles in new products that fulfil the same function.

8. **Repurpose**
   Repurpose. Incorporate parts from defective vehicles into new products to fulfil a different function - such as using old tires as construction material.

9. **Recycle**
   Recycle. Process materials and feed them back into the production cycle.

Additional:

- **Recover**
  Thermal recycling with energy recovery.

Source: VCÖ 2022, BMK 2021 | Chart: VCÖ 2022, License CC BY-ND
One example is the use of renewable, bio-based materials for construction to replace conventional materials. Austrian Federal Railways, ÖBB, offers vehicle parts as a service for other vehicle fleets as part of its spare parts and components remanufacturing activities.

**Passenger cars require many resources**

A passenger car weighs an average of 1.5 tonnes, with the largest share of its weight – over 46 per cent, coming from steel. Aluminium and plastic comprise over 13 per cent each while around 15 kilograms of copper are used. The total resource consumption to produce a vehicle averages 70 tonnes of material and resources. Production likewise generates around ten to eleven tonnes of greenhouse gas emissions total per passenger car. More than 1.3 million new passenger cars were registered in Austria over the past five years.

**Small instead of overweight vehicles**

Not only a reduction in the number of vehicles, but also shifting to smaller vehicles considerably reduces both CO₂ emissions and the use of resources. Comparing CO₂ emissions over the entire life cycle reveals that luxury-class cars with internal combustion engines produce nearly 30 per cent more than compact cars; for e-cars, this difference in CO₂ emissions can double for every kilometre driven. A luxury-class vehicle with an internal combustion engine likewise weighs on average around 50 per cent more than a compact car. At the same time, the battery of a mid-size electric SUV requires on average about a quarter more critical raw materials such as lithium, nickel and cobalt than that of an electric car in the smaller compact class.

**Promoting reuse and recycling**

Theoretically, up to 99.5 per cent of selected metals used in vehicles can be recycled. In Austria, at least 95 per cent of end-of-life vehicles must be recycled by weight since 2015. A large proportion of 85 per cent of these is materially utilised, including thermal recycling. Depending on the total mileage, 15 to 20 per cent of CO₂ emissions produced by a vehicle are generated during the production of an internal combustion car and one per cent during recycling. For a future-oriented value chain for batteries, there needs to be a higher level of material recycling and opportunities for reuse.

**Sustainable mobility consumes fewer raw materials and less energy**

Compared with a diesel passenger car, a public bus consumes around 77 per cent less energy per passenger-kilometre over the entire life cycle. By rail, the figure is as much as 85 per cent less. Energy use per passenger-kilometre can be reduced if the number of people per trip is increased. If a bicycle is used, energy use is 98 per cent lower than with the car. Walking is energy neutral, meaning no additional energy is used.

**Fewer vehicles through sharing**

If mobility services are used on demand instead of privately owned vehicles, the number of vehicles is also reduced. In addition to the expansion of traditional public transport, this requires an enhancement through on-demand buses, micro-public transport, car sharing or bike sharing.

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**For nine out of ten car journeys, only one person sits in the car. Nevertheless, the size and weight of cars have increased considerably, which worsens the CO₂ footprint.**

**Even for electric cars, size and weight worsen CO₂ footprint**

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<thead>
<tr>
<th>Kilogram of CO₂ equivalent in the life cycle</th>
<th>Petrol</th>
<th>Diesel</th>
<th>Electric (renewable power)</th>
<th>Electric (Austrian power mix)</th>
</tr>
</thead>
<tbody>
<tr>
<td>small car</td>
<td>52,710</td>
<td>68,050</td>
<td>66,860</td>
<td>36,050</td>
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<td>luxury-class car</td>
<td>1,200</td>
<td>1,800</td>
<td>2,000</td>
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<td></td>
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Source: Umweltbundesamt 2022; Chart: VCÖ 2022, License CC BY-ND
Planning a new world of circular mobility
The principles of a circular economy are fundamental to the transformation towards a sustainable transport system. A circular transportation system focuses on the movement of people and goods from A to B and not on the means of transport. At the heart of this is traffic reduction and the joint use of climate-friendly means of transport, which are integrated into a multimodal mobility system. For this, public transport is used in combination with on-demand vehicles as a flexible solution for the last mile. Walking and cycling are further cornerstones of resource-conserving mobility.

The future of circular mobility depends on further research and investment, the willingness to innovate and many creative solutions. The promotion of vehicular traffic by means of roadway infrastructure, for example, increases resource consumption and consequently CO2 emissions. In addition, there is a need for clear and effective EU-wide and national guidelines on vehicle design to ensure durability, the possibility of repair and the recycling of materials and raw materials. At the same time, it is important to build up a circular culture by raising awareness and advancing it with the help of feasible solutions.

VCÖ recommendations
Implement the circular economy across the entire value chain in the mobility sector
- Raise awareness of the circular economy in mobility along the entire value chain.
- Develop social and ecological requirements from raw material extraction to recycling at the EU level as well as in Austria.
- Reduce traffic volume and optimise vehicle utilisation.
- Expand the mobility system across the board to include sharing services. This will reduce the number of vehicles and thus the consumption of resources.

Design "Circular by Design" vehicles
- Design vehicles to be more durable and repairable.
- Use sustainable materials for the construction of vehicles, considering recycling and reuse in the design.
- Use vehicles that are more compact and efficient instead of those that are too heavy and overpowered.

Lina Mosshammer, VCÖ - Mobility with a future: „The circular economy makes mobility more sustainable. Planning over the entire cycle reduces not only the need for resources, but it also keeps them in the system over the longterm.”

Sources online at:
www.vcoe.at/publikationen/vcoe-factsheets

Developing and promoting Circular Mobility