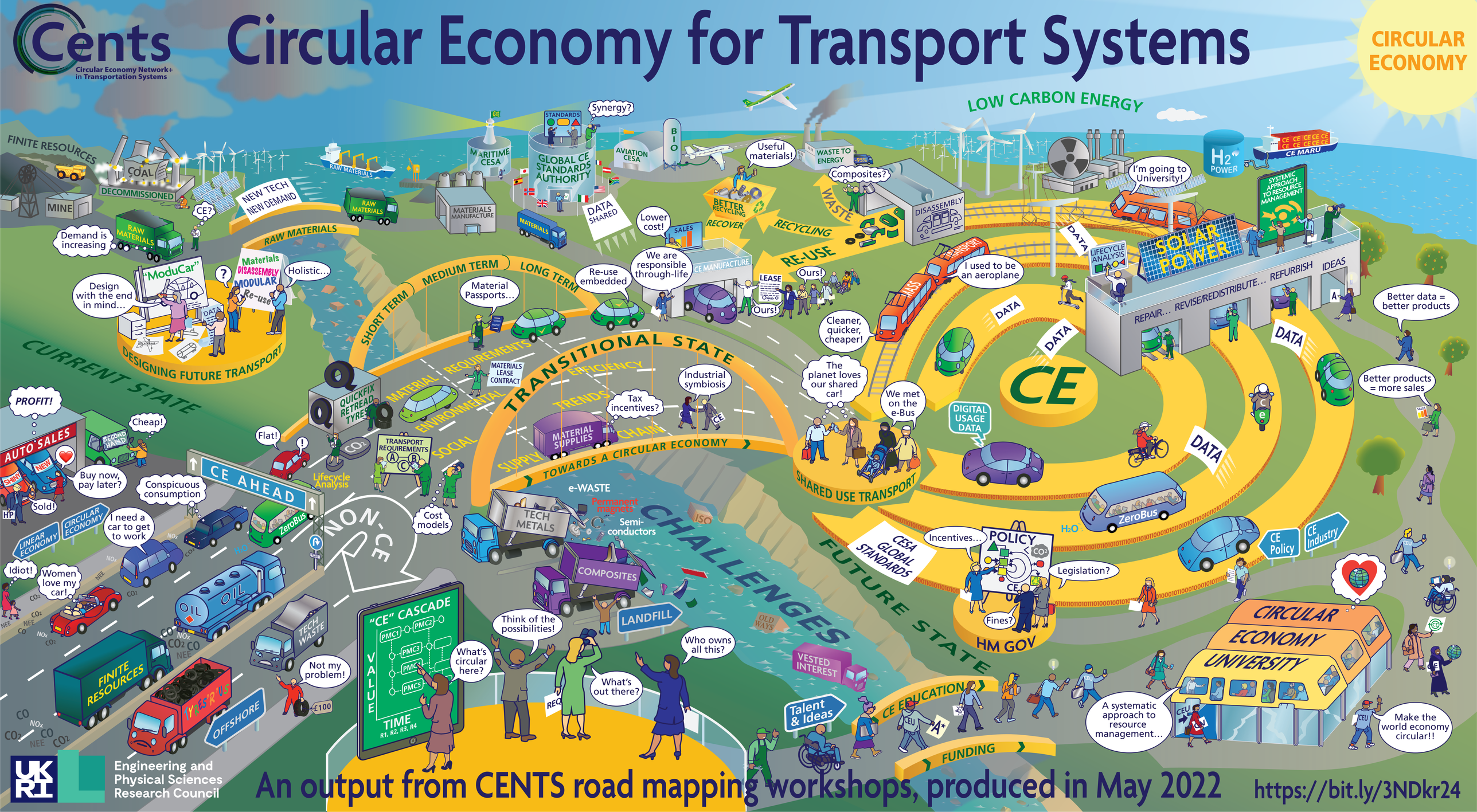
Circular Economy for Transport Systems

Cents
Circular Economy Network+ in Transportation Systems

CIRCULAR ECONOMY



UKRI Engineering and Physical Sciences Research Council

An output from CENTS road mapping workshops, produced in May 2022

https://bit.ly/3NDkr24

Circular Economy Network+ in Transportation Systems (CENTS)

ROADMAP NARRATIVE - Material use in transport systems for a circular economy

Context

The CENTS network vision is to build a community that focusses on the informed design and utilisation of more environmentally friendly, renewable and/or recyclable materials within transportation systems and delivers novel and effective end-of-life recycling, re-use and recovery options.

In support of this mission the network held a virtual workshop in December 2020 where the roadmap to move from the current state to the future vision of a circular economy for transport systems was considered. The key messages from this workshop are summarised below and captured within a 'rich picture'.

The workshop identified the characteristics of both the current and the future state for how materials are used in transport systems, and the key transitional activities necessary to move between the two. Within the workshop four themes were considered: material requirements, circular economy, social trends and supply chain. The key points from across these themes are summarised below.

The desired future state

The vision of a future state for materials use in transport systems within a circular economy is of a series of cascading lifecycles, where materials and products are held at the highest state of value for as long as possible, with recycling and recovery as the final stage after a full material lifecycle of reduce, re-use, refurbishment and remanufacture. These material loops will be pan-transport type, recognising that industrial symbiosis is required in order to facilitate the movement of materials through decreasing value chains and across different transport modalities, with positive cost benefits for manufacturers as well as consumers. The producer must retain responsibility throughout this material lifecycle, with the ability and capacity to track materials ownership, supported by effective data management, a digital platform and product passporting to understand who needs, and who owns, what material, when. The lifecycle and end-of-life focus will be developed from the design stage and re-use, sharing, disassembly and recycling will be built into initial design of vehicles. This will need to be supported by enhanced social acceptability of re-use, sharing and recycling, underpinned by a greater value attributed to valuing the things we have, rather than those not yet acquired. The future vision must be supported by sustainable energy production with an increasing de-carbonisation of energy for material extraction, production and recycling operations, with multi-fuel mixes across sectors although a heavy reliance on electricity for road and rail, and with shorter, more local, supply chains for materials. To support all aspects of the future vision the circular economy will require a skilled workforce that understands circularity and is holistically educated about products and end-of-life in addition to product efficiency and function.

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The current state

The current situation is of transport systems using a range of different materials, many of which are hard to re-use and recycle, with no coherent understanding or data on materials stocks, fate and content. Product design is focused on consumer attraction and functionality, rather than through-life use and end-of-life outcome. Most production lifecycles are linear or with a cascaded-use approach, with waste as the output, much of which is offshored, with little incentive for re-use or local consumption of materials even in resource-critical areas such as technology metals. There is no overall government strategic or policy approach and little joined-up thinking across transport sectors from either an industrial, or consumer, perspective. Transport systems are predominantly influenced by consumer choice, motivated by location and ease of use, not by sustainable material choice

Path to achieve the future state

To achieve the future state we must think more holistically about the transport system as a whole, to enable flexible transportation and to reduce the material requirement, as well as extending the material lifecycle once in use through systemic approaches to resource management and interdisciplinary collaboration. Business models must shift to circular economy focused approaches, requiring collaboration and pan-industry working to break down sector stovepipes. Consumers must be motivated to shift from car ownership to sharing and more dynamic public transport models and the full supply chain (consumers, stakeholders, producers) need to be educated on the material 'shadow' of products and services to enable good choices to be made and pressure to be placed on governments. There will need to be a coherent government strategy for circularity to set the requirement, and to map a demand perspective through foresighting technologies, to set the conditions for legislation and regulation. This demand will provide the context for government-derived incentives, both financial and practical, to encourage circular economy elements and initial risk-taking activity to break the status quo, supported by a programme of government-sponsored research focused on multi-dimensional approaches to the higher tiers in the circular economy. This should be supported by international standards to minimise the exporting of waste, mandate the supply chain outside the UK and encourage international agreements to address the global nature of materials supply and the transport sectors.

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SUMMARY OF ROADMAP KEY POINTS
Material use in transport systems for a circular economy

Current state	Future state
• Range of different materials in use, including composites which are particularly challenging for end-of-life management • Stove-piped government industrial strategies, not considering materials • Material lifecycles are linear, or with cascaded-use, with waste often off-shored • Little knowledge and understanding of materials stocks, fate and content • Limited recycling • Challenging to find high quality recycled material meeting technical requirements • Economic drivers for recycling are poor, including volatile commodity prices • Social and economic disincentives to try sustainable transport modes • Very few transport modes have circular options • Offshoring causes issues with circular economy principles • Regulation and legislation does not currently support circularity and little joined up government thinking	• Cascading lifecycles where materials and products held as high a state of value for as long as possible • Recycling and recovery the final stage after a full lifecycle of reduce, re-use, refurbishment and remanufacture created from initial design • Pan-transport sectors with industrial symbiosis required • Track material traceability and producer retains ownership through-life supported by data management and product passporting • Standardisation of materials • Public acceptability of sharing, public transport and low carbon vehicles • Vehicle ownership models shifted towards sharing • New supply chains with circularity in mind • Holistic approach to lifecycle assessment • Sustainable low-carbon energy production and low carbon multi-fuel mixes

Roadmap: Short term activities ~2025	Roadmap: Medium term activities ~2035	Roadmap: Long term activities ~2050
1. Design for disassembly and recycling 2. Explore lease over ownership 3. LCA studies to quantify footprint 4. Share best practice across sectors 5. Deal with missing and misplaced data 6. Better map and track current demand and supply 7. Increase understanding of lifecycles and downcycles 8. Public engagement on circular economy 9. Examine cost models to incentivise circularity	10. Taxation on imported materials 11. Make producers responsible for end-of-life 12. Incentives and tax relief for multiple use 13. Materials passports 14. Design for disassembly 15. Buy-back models established for vehicles 16. Mass transport attractive to users 17. Increase in gamification 18. Set LCA standards 19. Government funding, international agreements and legislated standards to make recycling economic 20. Disincentivise export of waste materials	21. Fines and taxes on primary materials 22. Engineering and performance standards designed around multiple use load cases 23. Technology support to reduce uncertainty with recycling 24. Business models change to be fully circular 25. Public spaces are only for users of shared vehicles 26. UK leads the way internationally in drafting agreements and standards 27. Industrial symbiosis for pan-sector material use 28. Continued digitalisation of supply chains