SHAPING THE FUTURE,
TOGETHER

IEA EV Task 52 “Electric Vehicles and Circularity”

Gerfried Jungmeier [1] and international Partners [2] from IEA EV Task 52

Reaching circularity is one of the main challenges of our global society and economy. The IEA EV Task 52 “Electric Vehicles (EVs) and Circularity” aims to analyse, discuss, and document the main challenges and opportunities for electric vehicles and their components towards reaching a higher circularity. Circularity issues of EVs are relevant in all phases of the life cycle – production, use and end-of-life. The 10 R-principles - Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle and Recover – are a guidance how materials and energy can be used and reused at their highest value while minimising waste and environmental impacts. Task 52 applies these 10Rs to electric vehicles (Figure 1) to explores potentials to enhance circularity with a focus on battery, charger, power electronics, electric engine, electricity grid and renewable electricity plants.

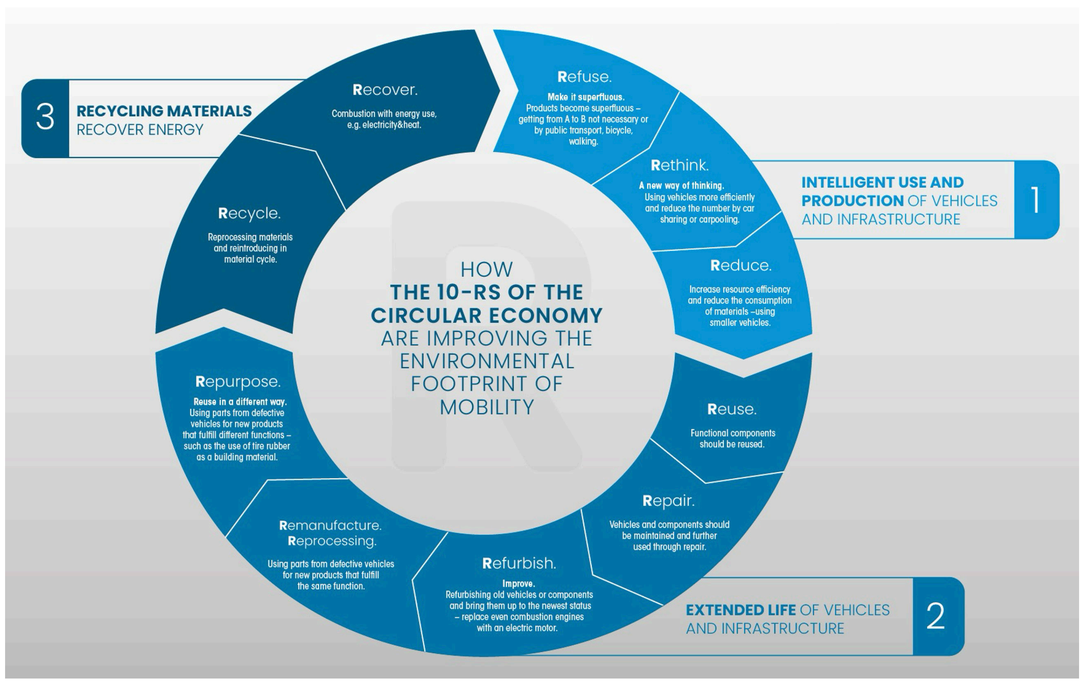

Figure 1: The 10 R-Principles of Circularity and electric vehicles

Definition Circularity

After the analyses of 22 national circularity strategies Task 52 developed a unique definition:

A transportation service is 100% circular, if in the whole life cycle - production, operation & end-of-life – the total mass of used materials consists only of reused components, recycled and renewable/bio-based materials and primary renewable energy whereas no waste and no emissions occur. That means no primary material (metal and minerals), no primary fossil energy (oil, gas and coal) and complete recycling or reuse of materials. A long lifetime and an intensive use in combination with high material and energy efficiencies is mandatory. The 10 R-Principles of Circularity are applied consequently to further improve circularity. To assess circularity between 0% and 100% the Circularity Potential (CPO) is calculated with the lifecycle-based circular and non-circular mass of the system´s in- and outflows.

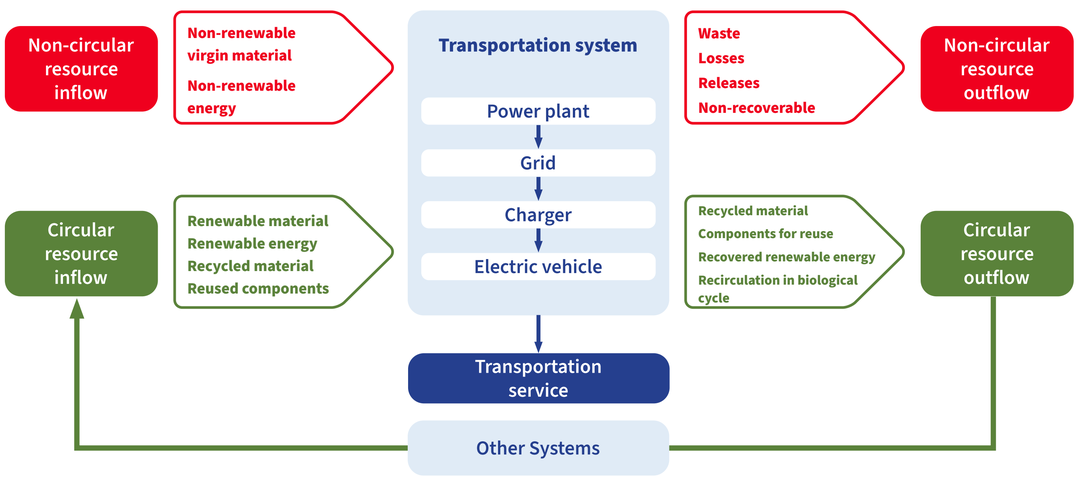

Figure 2: Lifecycle-based mass flows in the Inventory Analyses and Impact Assessment of circular and non-circular flows

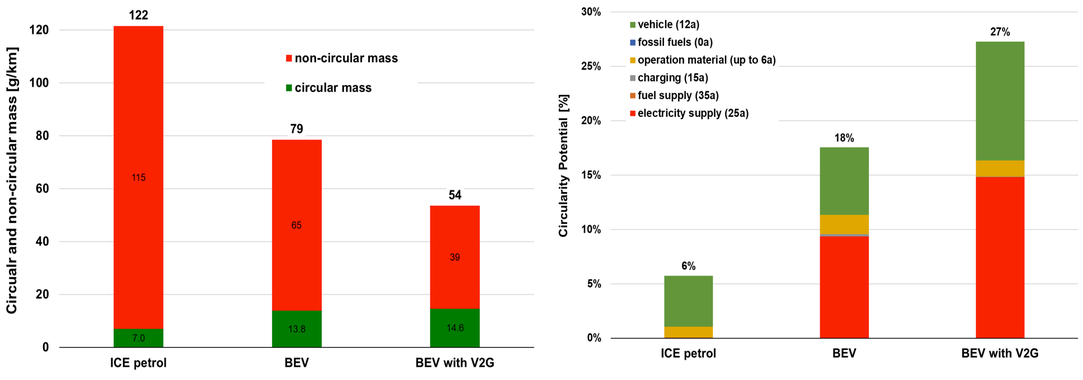

Figure 3: Comparison of Circularity Potential and (non)circular mass of ICE and BEV

Assessment Approach

The methodological elements to assess the Circularity Potential are

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  - Using the Material Circularity Index (MCI) developed by the Ellen MacArthur Foundation
  - Linear Flow Index ($LFI_{material}$): material specific
  - Utility Factor ($UF_{product}$): utilisation specific e.g. lifetime
  - Material Circularity Index (MCI): $MCI = LFI_{materials} * UF_{product}$
- Calculating the Circularity Potential
  - Apply dynamic LCA methodology with the time dependent mass flows
  - Setting of system boundary for vehicle and energy supply
  - Including cumulated primary energy demand in mass balance (Inventory)
  - Identifying circular and non-circular mass flows (Impact Assessment)
  - Calculating the circular and non-circular (Figure 2)
    - total mass (g/km)
    - critical and non-critical mass (mg_Sb_{eq}/km)
    - renewable and non-renewable mass (g_renewable mass/km)
- Initial case study on a transportation service (Figure 3)
  - Internal Combustion Engine (ICE) using petrol and
  - Battery Electric Vehicle BEV with Vehicle-to-Grid (V2G) using renewable electricity

Conclusions

- Task 52 has 11 partners in 9 countries and focuses on circularity assessment and industrial circularity use cases
- Definition of Circularity Potential is essential
- Initial methodological approach for circularity assessment using Life Cycle Assessment
- Mass balance of in- and outflows based on (non-)circular and (non-)renewable materials & energy
- Key factors for circularity: energy demand, types of materials, lifetime and intensity of use

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Spain:
IREC

UK:
Minviro

USA:
ARGONNE

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