Capacity Area B2 Topic 2.2 Deliverable 1 & 2

Report on total costs of mobility

Final sustainability assessment report

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The full integration framework of interdisciplinary technology assessment coupled with system models was implemented and applied to current and future cars and the associated energy supply chains both for a variety of technology options and for technology fleets.

Technology assessment extensively employed state-of-the-art modeling approaches such us Life Cycle Assessment (LCA), Impact Pathway Approach (IPA), Risk Assessment, Internal Cost Assessment (ICA), External Cost Assessment (ECA), Total Cost Assessment (TCA) and Multi-criteria Decision Analysis (MCDA). The modeling on the system level was based on our Swiss TIMES Energy Systems Model (STEM) and the global system model REMIND.

Three cases were analyzed:

- **Current (year 2019) and future (year 2050) car technologies with associated energy supply chains.** External costs were assessed and MCDA was carried out for 41 current and 58 future combinations of car drivetrains and fuels for reference years 2019 and 2050, respectively. Compared with the earlier evaluation scope both bio- and synthetic fuels are included in the current evaluation. The future results are scenario-dependent. MCDA was implemented using 12 performance indicators covering environmental, economic and social dimensions of sustainability supplemented by utility indicators important for consumers. For most sustainability indicators and for external costs the future technology performance is clearly better than the current one.
- **Current and future car fleets.** MCDA was carried out for the three scenarios generated using the STEM model (see additional information on deliverable **B2.3.2 – D2**). The three scenarios, i.e. Moderate (MCP), Ambitious (ACP) and Extremely Ambitious (EACP) correspond to different levels of ambition of alternative Swiss climate policies. MCP is a frozen policy based on already decided measures, ACP results in reduction of CO_2 emissions in 2050 by 80% and EACP by 100% (net zero emissions in Switzerland) compared to 1990. In addition, to cover the supply chains the matching scenarios from the global REMIND model were used. The more stringent the climate policy, the higher the electrification of the fleet. In EACP Battery Electric Vehicles (BEV) have the largest share in the fleet and are complemented by Fuel Cell Electric Vehicles (FCEV) and Plug-in Hybrid Electric Vehicles (PHEV) using bio- and synthetic fuels.

Here we focus on MCDA on the fleet level. The figure below shows the results of the basic MCDA case based on equal weighting of the environmental, economic and social criteria as well as of the underlying sub-criteria.

EACP performs best with regard to all indicators except for costs, metal depletion and with very small margin accident mortality. Varying preferences shows that emphasis on environmental and social criteria favors EACP followed by ACP while emphasis on economic criteria favors MCP followed by ACP.

EACP is clearly best concerning the primary goals of the Swiss energy policy, i.e. protection of climate and minimizing consumption of non-renewable energy sources. It is then not surprising that this is achieved at a cost that is higher than for the other scenarios since reaching the net zero emissions in Switzerland necessitates to use a number of very costly measures. This is manifested by much higher costs of CO_2 mitigation (per ton) when going from ACP to EACP compared to going from MCP to ACP. Given this APC stands out as a potential trade-off solution.

As expected all analyzed future fleet options perform better than the current fleet with regard to the environmental and social dimension but the opposite applies to the costs. The ownership cost in EACP increases by almost 70% compared to the current fleet.