

Appendix B1

Optimizing the lifetime CO₂ in a reducing fuel consumption market.

This appendix describes the whole of life CO₂ emissions, which is an integral part of the CO₂ sourced from fuel-consumed problem. Each time a vehicle is produced to replace one that is scrapped, or is part of market growth and therefore not replacing a scrapped vehicle, there are materials production and manufacturing energy (and CO₂) costs and possibly recycling (credits).

SAE-A has been involved in the only historical studies of the Australian motor industry manufacturing energy audits as far as we know. It is an extrapolation of the 1979 and 1996 audits that are used here. Not surprisingly as vehicles have become more complex the manufacturing CO₂ emissions have increased and as fuel efficiency in use has improved the proportions of manufacturing- recycling energy emissions have increased to about 25% of the lifetime CO₂ including the energy recovery from materials less the process energy in recycling. This recognizes the higher CO₂ emissions associated with the use of coal for electricity production etc.

To illustrate the concepts here in the first example it is assumed that the initial CO₂ is four times (this is on the low side) the first year in-service CO₂ (or equal to four years of fuel use). A constant average travel per year is selected (e.g. assume the fleet average of 15,000 km/y). The vehicle chosen emits 240 g/km CO₂ at the beginning and throughout its life. This vehicle is sold into a market that has a 2%pa improvement in fuel consumption so any replacement vehicle will have lower fuel consumption.

At present the median life of vehicles is just under 17 years. Examples are chosen here of 10 year, 15 year and 20 year lifetimes.

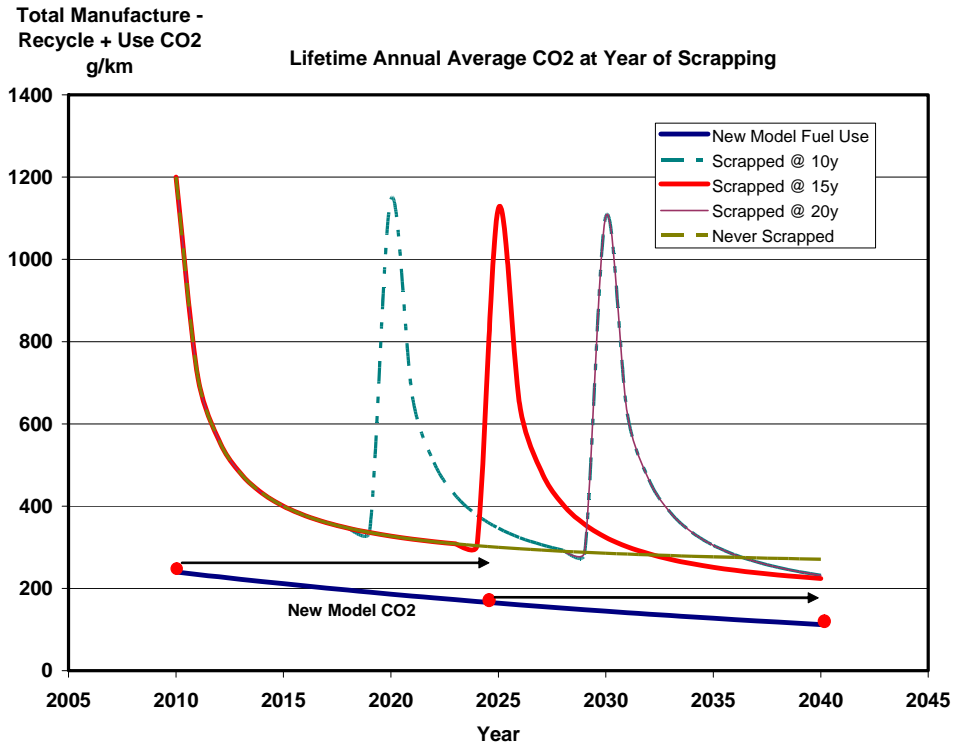


Figure B.1 Example of combined manufacture, recycle and in-use CO₂ annualized to the year in which the vehicle is scrapped or scrapped and replaced. Scenarios shown for replacement at 10, 15 and 20 years in a market where the CO₂ reduction of new models is about 2%pa commencing at 240 g CO₂/km in 2010 and manufacturing –recycle CO₂ is four times the year one CO₂ emission.

The modeling results in figure B.1 are for a new car entering service in 2010. The y axis of the graph is the annual average of the lifetime CO₂ up to the year when the vehicle is scrapped. Alternately the vehicle may be scrapped and replaced thus generating another jump in CO₂ associated with that process. Thus if the vehicle has a terminal accident at the end of its first year the average CO₂ in g km will be 5 times the fuel CO₂ emission (4x for manufacturing etc and one year's fuel use).

This information has important consequences in setting fuel consumption standards and encouraging rapid fleet turnover. It is clear in figure B.1 that of the three examples, the turnover at the 15 year interval gives the best result but is not necessarily the optimum. Table B.1 shows that in a 15 year period (the second) the lifetime CO₂ reduces by 25% compared with nearly 32% for the fuel alone.

Table B.1 Comparison of life-time and fuel sourced CO₂

Year	2024	2039	Difference %
CO ₂ from fuel alone g/km	168.4	115.2	31.6
CO ₂ from lifetime equivalent g/km	304.0	228.2	24.9

The optimum scraping age for vehicles is shown in figure B.2. It can be seen that in a slowly improving fuel consumption market of 1%pa and a manufacture-recycle CO₂ equal to six years of fuel use that the vehicle should only be replaced after 25 years.

Years of Service Needed to Optimize Manufacture-Recycle Energy at Various FC/y Reductions

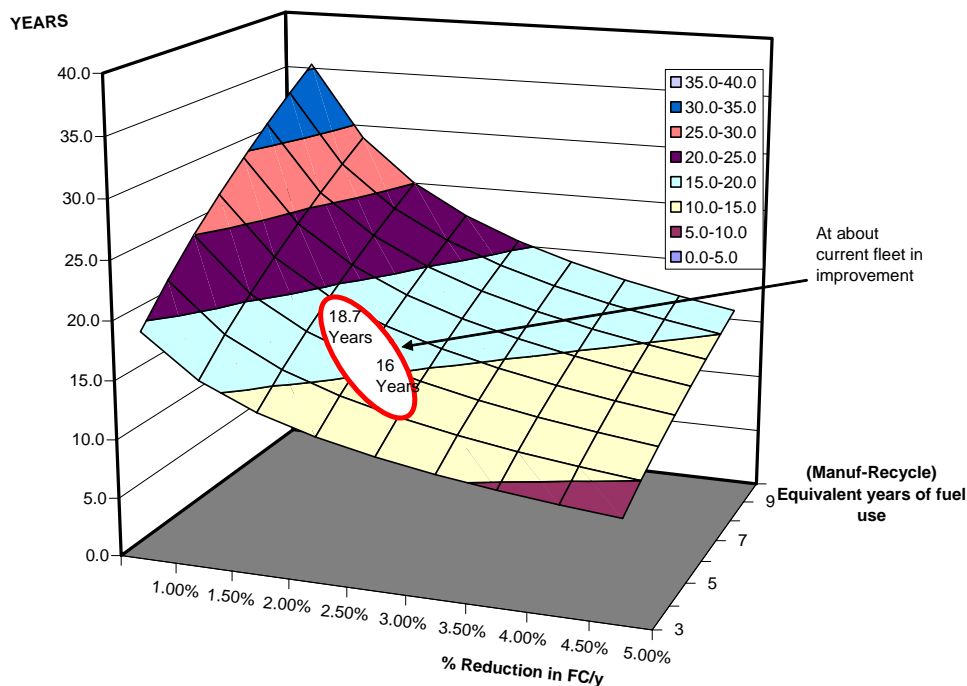


Figure B.2 Years needed to optimize the benefit for given levels of new model fuel consumption improvement per annum at a range of manufacture-recycle energies.

In a market with higher improvement such as 2%pa as occurring at present the optimum is about 16 to 18 years.

It might be expected that the manufacturing energy is proportional to the vehicle mass. It is unlikely to be the case because the audits show that substantial amounts of gas and electricity are used for climate control in the manufacturing plant and in materials manufacture. Moreover, there is a tendency for very efficient vehicles to use exotic, high manufacturing energy components such as magnesium, rare earth magnets and battery components. So until evidence is available to the contrary it would be precautionary to assume no variation in

manufacturing energy with vehicle mass especially in view of the limited mass range for the common passenger car fleet viz 1185 kg for a Toyota Corolla to 1617kg for a Holden Commodore. A Toyota Prius weighs 1325 kg

The policy implication from this analysis is that measures (such as high standing charges), which would discourage vehicles from seeing out their useful lifetimes, should not be implemented. Rather measures which move any costs related to vehicle use such as accident risks, road wear and so on should be shifted to fuel costs to reduce fuel use and CO2 reduction. Certainly best practice in low CO2 emission vehicle production should be encouraged. Moves out of coal based electricity to gas (or waste or renewable) fired electricity production and use gas for heating and cooling for heat pumping and air conditioning are basic examples.