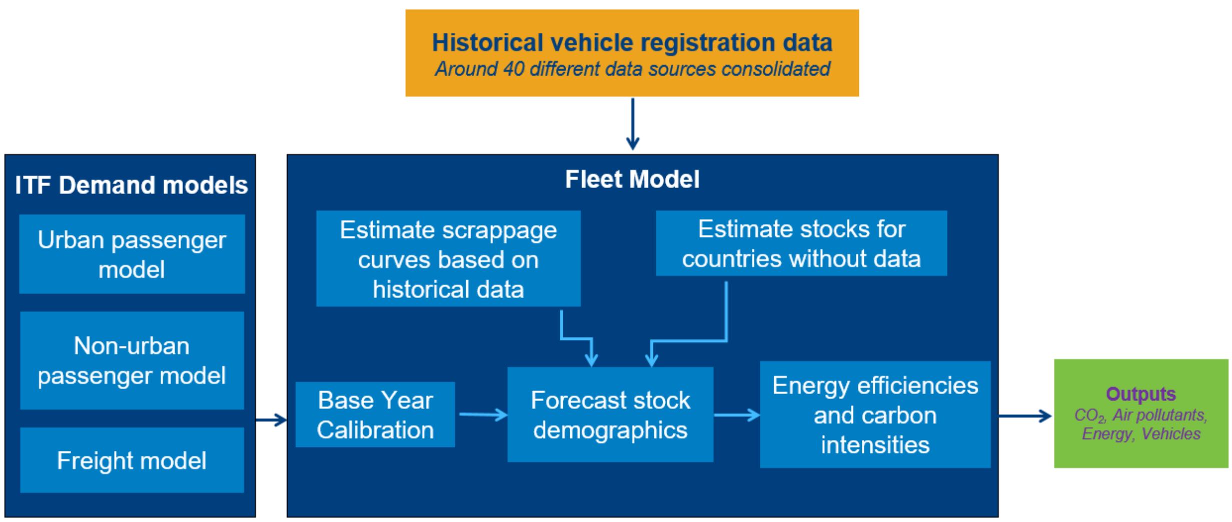
ITF Fleet Model overview

The ITF vehicle fleet model is used to estimate the evolution of vehicle fleets into the future based on historical fleet data, projected future demand for transport from the ITF demand modelling suite and scenarios of technology adoption. The ITF fleet model outputs the number of vehicles, energy use and CO_2 and air pollutant emissions over time.

The general model framework is presented in Figure 1.

Figure 1: ITF Fleet model framework



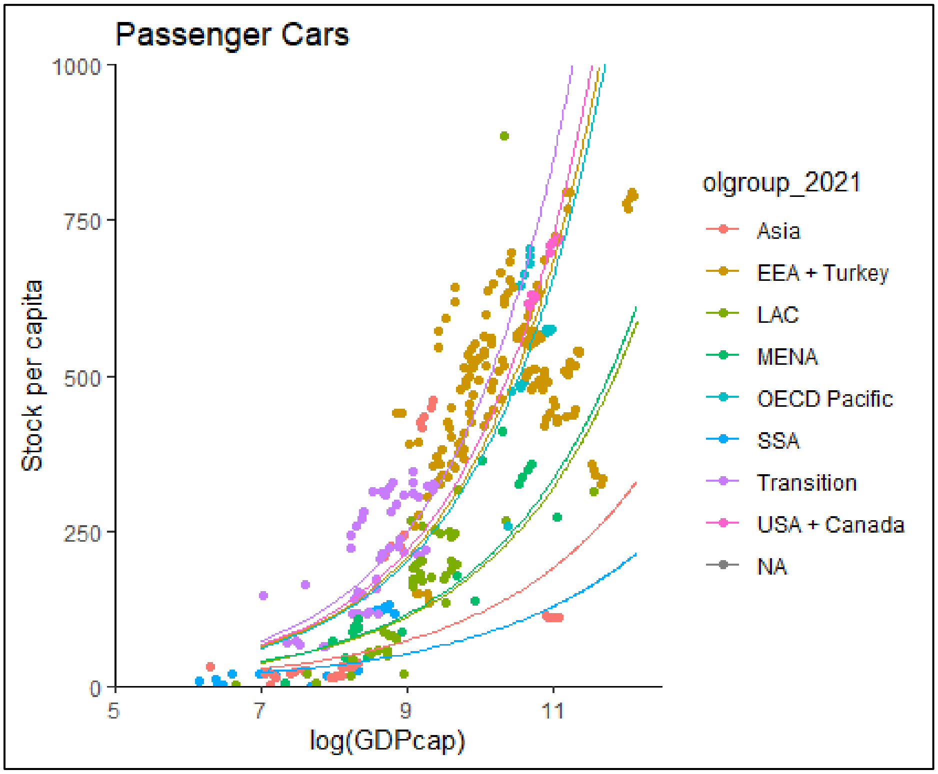
Source: ITF

The model includes estimates of the main outputs for nine global regions and the following vehicle types: Two and three-wheeled vehicles (2&3Ws), Passenger Cars, Buses, Light Commercial Vehicles (LCVs), Lorries, Road Tractors, Airplanes, Passenger Trains, Freight Trains and six different families of ships. The model does not currently distinguish between urban and non-urban vehicle fleets (see Figure 2).

The fleet model workflow proceeds as follows:

1. Estimate base year vehicle fleets
   - Aggregate available historical vehicle registration data
   - Estimate Weibull scrappage curves based on historical vehicle registration data
   - Calculate the demographics of vehicle fleets based on the Weibull curves
   - Perform regressions to estimate remaining parameters for missing countries and vehicle types

Figure 2. Fleet regional calibration process



Source: ITF

2. Estimate future vehicle fleets
    - Changes in demand from ITF demand model forecasts and vehicle scrappage between years stimulate new vehicle sales.
    - Enhance the fleet with information on powertrain type, vehicle fuel economy, vehicle-specific mileage
    - Use technology scenarios to influence the technical characteristics of new vehicle sales (powertrain type, energy efficiency improvements etc.)

Time series data on the number of vehicle registrations in each country, vehicle type and powertrain type are used to understand the composition of vehicle fleets globally. Numerous data inputs are compared to cross-validate and ensure internal consistency; these include statistics collected by ITF as well as from other international organisations and national sources.

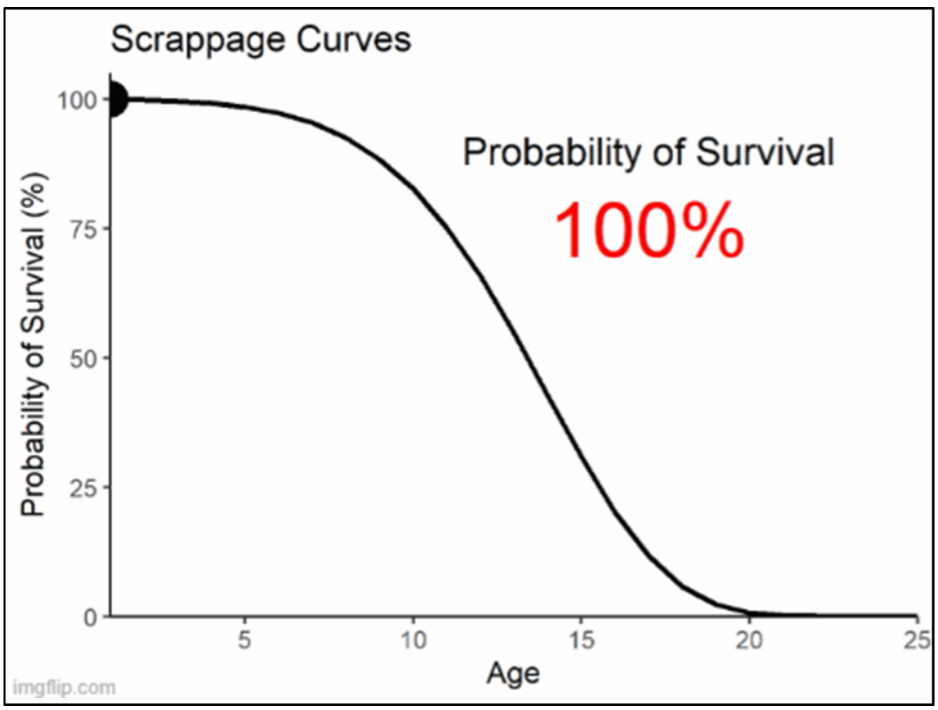
The model estimates survival curves based on known vehicle sales and fleet data. The Weibull estimation routine selects an optimum survival curve for each country, year and vehicle type. The average vehicle probability of survival Φ is given by the equation:

$$\phi = e^{-\left(\frac{a+b}{T_C}\right)^{b}}$$

Where *a* is the age of the vehicle in years (new vehicle age=0), *b* is the failure steepness and T_c is the characteristic lifetime (a constant). The observed vehicle activity in ITF demand models provides the guide for estimate the yearly survival of vehicles and the need of replacement or addition given the increasing demand.

These curves are used to estimate the lifetime of different vehicles over time. When a vehicle is scrapped it must be replaced by a new vehicle. Similarly, if transport demand using a specific vehicle increases overtime, additional new vehicles must be added to the fleet to satisfy demand. These factors govern the size of vehicle fleets and their demographics over time. Figure 3 shows an example of a scrappage curve of one vehicle in one region.

Figure 3. Scrapping curve profile



Source: ITF

Vehicle fleets are joined with information on their energy efficiency, powertrain, fuel type and CO_2 emissions intensity into the future. These are based on scenarios defined by policy ambitions. The Current Ambition scenario includes assumptions defined by existing policy and publicly stated ambitions. The High Ambition scenario is defined based on higher ambitions aiming to meet the ambitions of the Paris Agreement.

The model provides the yearly new sales composition by powertrain, vehicle type and region, as well as the total fleet and the age distribution. This allows deriving the energy consumption of the vehicles, given the activity estimated in the other ITF demand models (vehicle-km) and the related CO_2 and local pollutant emissions (tank-to-wheel and well-to-tank).

'High-with-Low' scenario information

The ITF models were designed and further updated to estimate and evaluate the impact of policy measures on transport activity and related emissions under two main scenarios: *Current Ambition* and *High Ambition*.

The *Current Ambition* scenario builds on existing policies and commitments to estimate the current pathways of transport demand and related emissions. In contrast, *High Ambition* targets more profound changes in the transport sector on demand management (generation control and sustainable modal diversion) and technological breakthrough. It was built by the ITF in 2020 for the preparation of the ITF Transport Outlook 2021 (ITF, 2021), and adjusted for the ITF Transport Outlook 2023 (ITF, 2023) since. It is the result of an international survey on current transport policies and technology development implementation worldwide, filled by many experts in the ITF network.

Table 1 shows measures implemented in the ITF Fleet Model for the *High Ambition* scenario and their calendar.

Table 1. ITF Outlook 2023 High Ambition policy scenario to transition to greener vehicle fleets

2020s	2030s	2040s
Vehicle fleets continue to turnover in line with historical trends and to meet travel demand. New vehicle efficiency improvements double from historical trends (road vehicles) driven by more stringent fuel economy standards. Aviation efficiency improvements increase to 3% per year.	100% of sales of new passenger vehicles and vans in UCAN, ENEA and EEA + Turkiye are ZEV by 2035 in line with GFEI Zero pathway. 100% of new bus sales in leading markets (UCAN, ENEA, EEA + Turkiye) are ZEV by 2030. 100% of new 2&3Ws in all regions are ZEV by 2035.	100% of sales of new passenger vehicles and vans in emerging markets by mid-decade are Zero emission in line with GFEI Zero pathway. 100% of new bus sales in remaining markets are zero emission by 2040. 100% of sales of new Heavy Duty Vehicles are Zero emission in leading markets by 2040, and in emerging markets by the end of the decade
		All new trains are zero emission by 2040 in leading markets (UCAN, ENEA, EEA+Turkiye) and by 2050 in remaining markets.
The roll-out of EV charging networks is accelerated to give consumers confidence and to support the EV fleets that are beginning to emerge.	EV charging networks continue to be rolled out..	Growing fleets and consumer confidence, coupled with better technology means fewer chargers are needed per car.
SAF mandates are introduced in the EU and US according to ambitions set out in the "Refuel EU" and "SAF Grand Challenge". The carbon intensity of fuels are estimated as per CA.	SAF mandates are rolled out and alternatives to conventional fuels begin to come down in price. The SAF mandates expand to other regions. Aircrafts with electric powertrains become available and	Commercial applications of electric aircraft in niche sectors. SAFs make up 100% of fuels globally by 2050. The lifecycle emissions of biogenic and

	begin to take share for short-haul flights with low passenger capacities.	synthetic pathways are calculated as detailed in the column "2020s".
	Initial deployment of zero emission shipping fuels in green corridors.	Zero emissions fuels make up 100% of shipping fuels by 2050. Electrification of short sea shipping routes in line with Kersey et al. (Rapid battery cost declines accelerate the prospects of all-electric interregional container shipping, 2022) by 2050.
	Signatories of the Global Memorandum of Understanding on Medium and Heavy Duty Vehicles reach 30% ZEV sales in HGVs in 2030.	Signatories of the Global Memorandum of Understanding on Medium and Heavy Duty Vehicles reach 100% ZEV sales in HGVs in 2040. Non-signatories reach 30% of ZEV sales in 2040 and 100% in 2050.

Note: Tank to wheel emissions

References

ITF. (2021), *ITF Transport Outlook 2021*., Paris: OECD, https://doi.org/10.1787/16826A30-EN.

ITF. (2023), *ITF Transport Outlook 2023*, https://doi.org/https://doi.org/https://doi.org/10.1787/b6cc9ad5-en.