**Short technical note**

The DPP Tool for passenger transport proposes a user-friendly approach to develop a narrative based on the main categories of transformations for this sector and translate it into quantitative assumptions.

This second step of the methodology (See page Discover) introduces some online modelling constraints reducing the flexibility of assessment achieved during the exploratory and manual research projects. However, we open the widest possible range of assumptions with more than 24 questions and related indicators.

Calibration data: In-country research partners provide the calibration data.

Projection to 2050: All assumptions are made for the 2050-value of each variable and the 2020-, 2030-, 2040-values are computed on a linear basis between the calibration year and 2050.

Assumptions in 2050: Here below, we describe how the different assumptions in 2050 are “used to compute” emissions and other indicators.

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| **Storyline categories** | **2050 - Assumption variables** | **Used to compute** |
| A1 – Demography and economics | Population |  |
| A1 – Demography and economics | Household size |  |
| A1 – Demography and economics | Household income  Or alternative assumptions:  Average annual growth rate of GDP and total disposable incomes in share of the GDP | (1) Average annual growth rate of GDP considering that disposable incomes represents 30% of GDP.  Or (1) Household income |
| A2 – Human settlement, land development and spatial organization | Share of the population living in metropolitan areas | (2) Population living in metropolitan and non-metropolitan areas |
| A2 – Human settlement, land development and spatial organization | Annual kilometers travelled per capita for constrained activities (e.g. constrained mobility) for metrop households | (3) Constrained mobility for people living in metropolitan areas |
| A2 – Human settlement, land development and spatial organization | Difference between constrained mobility in non-metropolitan and metropolitan areas | (4) Constrained mobility for people living in non-metropolitan areas= (1+Difference) x (Constrained mobility for people living metropolitan areas) |
| A3- Sociocultural practices and lifestyles | Share of constrained mobility for metropolitan households reduced due to teleworking  Or alternative assumptions:  Share of metropolitan population affected by teleworking and number of days fully teleworked every month | (5) Share of the metropolitan population affected by teleworking supposing 4 days teleworked over 20 working days by month.  (6) Constrained mobility in metropolitan areas integrating teleworking effects = (3) x (1 – Share reduced by teleworking)  (5) Or Share of constrained mobility in metropolitan areas reduced due to teleworking  (6) Constrained mobility in metropolitan areas integrating teleworking effects = (3) x (1 – Share reduced by teleworking) |
| A3- Sociocultural practices and lifestyles | Share of constrained mobility for non-metropolitan households reduced due to teleworking  Or alternative assumptions:  Share of non-metropolitan population affected by teleworking and number of days fully teleworked every month | (7) Share of the non-metropolitan population affected by teleworking supposing 4 days teleworked over 20 working days by month.  (8) Constrained mobility in non-metropolitan areas integrating teleworking effects = (4) x (1 – Share reduced by teleworking)  (7) Share of constrained mobility in non-metropolitan areas reduced due to teleworking  (8) Constrained mobility in non-metropolitan areas integrating teleworking effects = (4) x (1 – Share reduced by teleworking) |
| A3- Sociocultural practices and lifestyles | Variation compared to 2010-value of occupancy rates of cars in four different situations:   * in metropolitan areas and for constrained trips * in metropolitan areas and for non-constrained trips * in non-metropolitan areas and for constrained trips * in non-metropolitan areas and for non-constrained trips   Variation compared to 2010-value of occupancy rates of buses in four different situations:   * in metropolitan areas and for constrained trips * in metropolitan areas and for non-constrained trips * in non-metropolitan areas and for constrained trips * in non-metropolitan areas and for non-constrained trips | (9) Car and bus occupancy rates in the four different situations (passengers/vehicle) |
| A4- Technological development of vehicles | Variation compared to 2010-value of energy consumption of new cars for three different type of motorizations:   * Thermal combustion motorization * Full battery electric motorization * Fuel cell electric motorization | (10) Car energy consumption for three type of motorization:   * Thermal combustion (MJ/vkm) * Full battery electric (kWh/vkm) * Fuel cell electric (MJ/vkm) |
| A4- Technological development of vehicles | Average purchase price of five different car technologies:   * ICE liquid fuels (ICE LF) * ICE natural gas (ICE NG) * Battery Electric Vehicle (BEV) * Plug-in Hybrid Electric Vehicle (PHEV) * Fuel Cell Electric Vehicle (FCEV) |  |
| A4- Technological development of vehicles | Theoretical mileage life of the different car technologies:   * ICE LF and NG * BEV * PHEV * FCEV |  |
| A4- Technological development of vehicles | Variation compared to 2010-value of energy consumption for the other modes and motorizations:   * 2W – ICE * 2W – electric * Buses – ICE LF and NG, * Buses electric * Rail – ICE * Rail- electric * Air domestric – ICE * Air international - ICE | (11) Energy consumption for the eight type of modes/motorization :   * 2W – ICE (MJ/vkm) * 2W – electric (kWh/vkm) * Buses – ICE LF and NG (MJ/vkm) * Buses electric (kWh/vkm) * Rail – ICE (MJ/pkm) * Rail- electric (kWh/pkm) * Air domestric – ICE (MJ/pkm) * Air international – ICE (MJ/pkm) |
| A5 – Fuel generation and carbon content | Share of final electricity consumption produced by:   * Coal * Liquid fuels * Natural gas * Nuclear * Renewables | (12) Average electricity carbon content calculated from electricity mix and related carbon intensity of electricity assets (gCO2/kWh). |
| A5 – Fuel generation and carbon content | Potential of sustainable and renewable energy available for transport, for three type of energy (in EJ):   * Liquid biofuels * Gaseous biofuels (synthetic gas, biogas) * Hydrogen from renewable electricity |  |
| A5 – Fuel generation and carbon content | Average final fuel prices (including taxes) for the four main different energies and across all modes:   * Liquid fuels (diesel, gasoline, kerosene, liquid biofuels) (in eur/liter) * Methane fuel (natural gas, syngas, biogas) (in eur/kg) * Electricity (in eur/kWh) * Hydrogen (in eur/kg) |  |
| A6 – Penetration of alternative motorizations and car stock | Motorization rate of the population (nb of veh/ 1000 inhabitants) | (13) Car stock = Population x Motorization rate |
| A6 – Penetration of alternative motorizations and car stock | Share of the five different car technologies in the stock:   * ICE LF * ICE NG * BEV * PHEV * FCEV   Or alternative assumptions:   * Average real life of cars in years * Share of sales for the period 2041-2050 for the different car technologies: ICE LF, ICE NG, BEV, PHEV, FCEV | (14) Considering an average real life of cars of around 14years, the stock loss rate amounts to 7,1% every year  (15) Annual sales for each technology = Variation of car stock + car losses by technology  (14) Annual stock loss rate = 1 / Average real life of cars  (15) Share of the five different car technologies in the stock  (16) Considering that each car runs the same annual mileage in average, and that PHEV and FCEV run respectively 85% and 25% of the vkm with direct electricity, we compute the shares of the car-vkm made with the different fuels.  (17) The average car price (eur/vkm) is computed based on the theoretical mileage life of each technology, the purchase prices, the final fuel prices and an additional insurance and maintenance costs representing 50% of the purchase price over the lifetime. Combined with the car occupancy rates, the car price in the four different situations is computed (eur/pkm). |
| A6 – Penetration of alternative motorizations and car stock | Share of the vehicle kilometers made by 2W with electricity  Share of the vehicle kilometers made by Bus with electricity  Share of the vehicle kilometers made by Bus with methane gas  Share of the vehicle kilometers made by rail with electricity | (18) Share of the vehicle kilometers made by 2W: with electricity and the rest with liquid fuels (%vkm)  Share of the vehicle kilometers made by Bus: with electricity, with methane gas and the rest with liquid fuels (%vkm)  Share of the vehicle kilometers made by rail: with electricity and the rest with liquid fuels (%vkm) |
| A7 – Income dedicated to transport, modal distribution and costs | Share of disposable income dedicated to transport activities for people living in the two different areas: metropolitan and non-metropolitan | (19) Total budget of individuals in metropolitan and non-metropolitan dedicated to transport |
| A7 – Income dedicated to transport, modal distribution and costs | Modal shares of the constrained mobility in metropolitan and non-metropolitan areas:   * Car * 2W * Bus * Rail * Air domestic * Air international * Non-motorised   Or alternative assumptions:  Modal prices for the constrained mobility in metropolitan and non-metropolitan areas for:   * 2W * Bus * Rail * Air domestic * Air international * Non-motorised | (20) Number of kilometers travelled in metropolitan and non-metropolitan areas for constrained activities among the different modes = Modal Shares x (6)(7) Constrained Mobility  Modal prices for the constrained mobility in metropolitan and non-metropolitan areas for (See specific details after the table):   * Car (defined before) * 2W * Bus * Rail * Air domestic * Air international * Non-motorised   Or (20) Modal shares of the constrained mobility in metropolitan and non-metropolitan areas (See specific details after the table):   * Car * 2W * Bus * Rail * Air domestic * Air international * Non-motorised |
| A7 – Income dedicated to transport, modal distribution and costs | Modal shares of the non-constrained mobility in metropolitan and non-metropolitan areas:   * Car * 2W * Bus * Rail * Air domestic * Air international * Non-motorised   Or alternative assumptions:  Modal prices for the non-constrained mobility in metropolitan and non-metropolitan areas for:   * 2W * Bus * Rail * Air domestic * Air international * Non-motorised | (21) Transport Budget dedicated to non-constrained mobility in metropolitan and non-metropolitan areas  Modal prices for the non-constrained mobility in metropolitan and non-metropolitan areas for (See specific details after the table):   * Car (defined before) * 2W * Bus * Rail * Air domestic * Air international * Non-motorised   Or (21) Modal shares of the non-constrained mobility in metropolitan and non-metropolitan areas (See specific details after the table):   * Car * 2W * Bus * Rail * Air domestic * Air international * Non-motorised |
| A8. Speed, infrastructure and time dedicated to transport | Speeds of travel for constrained activities by modes in metropolitan and non-metropolitan areas:   * Car * 2W * Bus * Rail * Non-motorised   Note: air transport is excluded of the calculation. | (22) Combined with changes in modal distribution in kilometers, we can assess daily time dedicated to transport for constrained activities in metropolitan and non-metropolitan areas. |
| A8. Speed, infrastructure and time dedicated to transport | Speeds of travel for non-constrained activities by modes in metropolitan and non-metropolitan areas:   * Car * 2W * Bus * Rail * Non-motorised   Note: air transport is excluded of the calculation. | (23) Combined with changes in modal distribution in kilometers, we can assess daily time dedicated to transport for non-constrained activities in metropolitan and non-metropolitan areas. |

Final computation:

* Total mobility by modes: Based on the modal distribution and the individual mobility for the constrained and non-constrained activities of people living in metropolitan and non-metropolitan areas, we can compute the total mobility by modes.
* Final energy consumption by modes and fuels: Based on the vkm and pkm-distribution by modes and fuels, and the different energy consumption by vkm and pkm, we can compute the total final energy consumption by modes and fuels.
* CO2 emissions by modes and fuels: Based on the final energy consumption by modes and fuels, and the different energy emission factors, we can compute the total CO2 emissions by modes and fuels.

Specific details for section A7:

*We solve the following system of equations to compute the modal shares and modal prices for the constrained activities of people living in metropolitan areas. The same calculation is used to compute the modal shares and modal prices for the constrained activities of people living in non-metropolitan areas and the non-constrained activities of people living in metropolitan and non-metropolitan areas.*

1. We suppose that the modal choice for mobility is the result of an optimization under the price constraint and that the mobility could be represented by this type of utility function M:

x = nb de mode

The solution of the maximization of this utility function is:

Yc = Revenues dedicated to constrained mobility; pi = price of mode i ; ai and bi constant

1. Other equations:
   * TransportBudget = Yc =
   * IndividualMobility =
   * IndividualMobility\*Share(Modei)=pkmi
   * Computed before: Price of cars, Individual mobility for constrained activities
   * QualityOfModei = ai\*bi represents the quality of service proposed by the different modes and we suppose they will not change between 2010 and 2050.