EVer Energy and Transport

POSTER – OVERVIEW OF CURRENT PASSENGER VEHICLE DRIVE TECHNOLOGIES & FUELS (JAN 2021)

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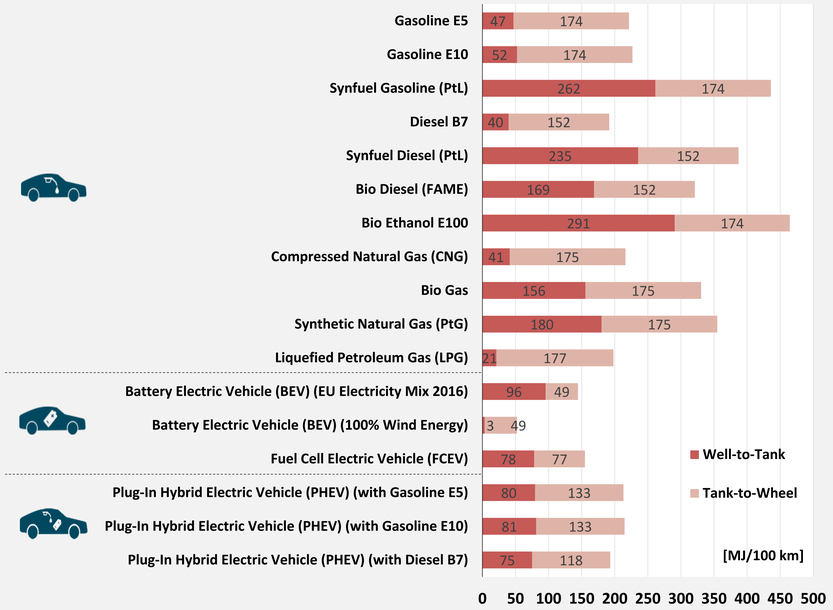
DLR

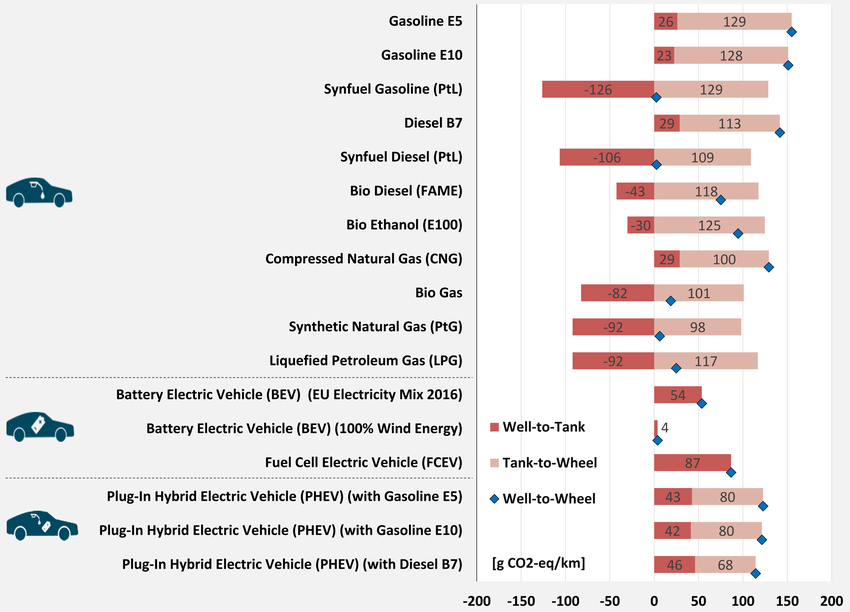
ENVIRONMENTAL CHARACTERISTICS

ENERGY CONSUMPTION: WELL-TO-TANK (WTT) & TANK-TO-WHEEL (TTW) (F.1)



(F.1), (F.2): - References: [8] - [10], [30]
- Figures represents TTW values for year 2020 based on the calculated average between TTW values of 'scenario 2015' for the maximum and TTW values of 'scenario 2025+' for the minimum energy consumption [8]
- For TTW values from scenario 2015, a correction factor of 1.2 is considered for converting NEDC to WLTP values [8]
- Chosen pathways represent the 'selected pathways' from [10], Table 56
- PHEV: Calculations consists of combustion based and electrical average energy consumption:
PHEV minimum: Values are calculated with procedure as descripted before (TTW values from 'scenario 2025+' [8])
PHEV maximum: same TTW values as for respective ICEV pendant is assumed (e. g. max value PHEV Gasoline E5 = max value Gasoline E5)

EMISSIONS: WELL-TO-TANK (WTT) & TANK-TO-WHEEL (TTW) (F.2)

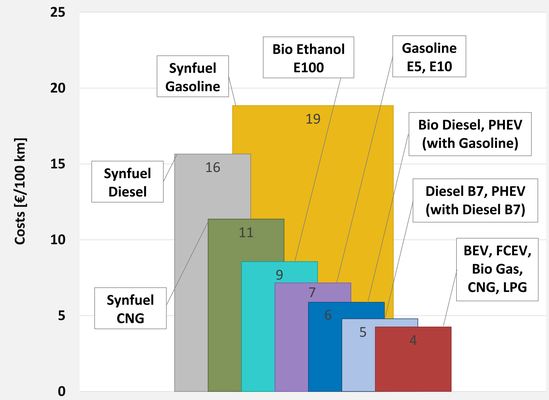


(F.1), (F.2): Formulas from [8] – [10]:

- WTT Energy Consumption $\left[\frac{\mathrm{MJ_{energy}}}{100\ \mathrm{km}}\right]$ = WTT Energy Consumption $\left[\frac{\mathrm{MJ_{energy}}}{\mathrm{MJ_{fuel}}}\right]$ × TTW Energy Consumption $\left[\frac{\mathrm{MJ_{fuel}}}{100\ \mathrm{km}}\right]$ ([8], [9])
- WTT GHG Emission $\left[\frac{\mathrm{g\,CO_2\text{-}eq.}}{\mathrm{km}}\right]$ = TTW energy consumption $\left[\frac{\mathrm{MJ_{energy}}}{100\ \mathrm{km}}\right]$ × WTT Energy Specific GHG Emissions $\left[\frac{\mathrm{g\,CO_2\text{-}eq.}}{\mathrm{MJ_{energy}}}\right]$ ([8], [9])
- TTW CO_2 Emission Factor $\left[\frac{\mathrm{kg}}{\mathrm{MJ}}\right] = \frac{\mathrm{CO_2\ Emission\ Factor}\left[\frac{\mathrm{kg}}{\mathrm{kg}}\right]}{\mathrm{Lower\ Heating\ Value}\left[\frac{\mathrm{MJ}}{\mathrm{kg}}\right]}$, Energy Density $\left[\frac{\mathrm{MJ}}{\mathrm{l}}\right]$ = Lower Heating Value $\left[\frac{\mathrm{MJ}}{\mathrm{kg}}\right]$ × Density $\left[\frac{\mathrm{kg}}{\mathrm{l}}\right]$ ([8])
- TTW GHG Emission $\left[\frac{\mathrm{g\,CO_2\text{-}eq.}}{\mathrm{km}}\right]$ = TTW Energy Consumption $\left[\frac{\mathrm{MJ_{fuel}}}{100\ \mathrm{km}}\right]$ × TTW CO_2 Emission Factor $\left[\frac{\mathrm{kg}}{\mathrm{MJ_{fuel}}}\right]$ ([8])

FINANCIAL CHARACTERISTICS

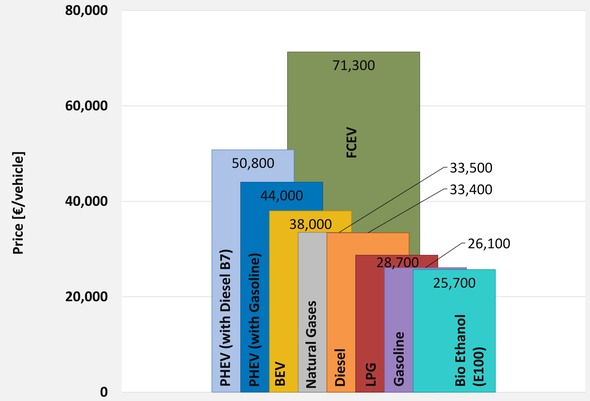
VEHICLE OPERATIONAL COSTS (F.3)



(F.3) - References: [3], [6] - [10], [12], [22], [23], [28], [29]
- Synfuel Gasoline: Calculation of energy specific CO2 emission factor and energy density based on assuming equal fuel characteristics as fossil gasoline;
- Additional notes: see (F.1, F.2)

- Formula: Operational Cost [€] = Energy Consumption $\left[\frac{\mathrm{MJ}}{100\ \mathrm{km}}\right] \times \frac{\mathrm{Fuel\ Price}\left[\frac{€}{\mathrm{l,kg}}\right]}{\mathrm{Energy\ Density}\left[\frac{\mathrm{MJ}}{\mathrm{l,kg}}\right]}$, X in unit kg or l - depending on the fuel type

VEHICLE PURCHASE PRICE (F.4)



(F.4): - References: [1], [2], [4], [5], [11], [14], [16], [24]
- Meta-analysis of the ADAC vehicle data base for each powertrain within assumptions (see GENERAL ASSUMPTIONS), average between minimum and maximum value
- Bio Ethanol (E100): Prices were in Brazilian Real; Exchange rate from August 2nd: 1 Brazilian Real = 0.16 € [11]
- LPG: Purchase price of a Gasoline (E5) vehicle with extra conversion costs (min: 1,800€, max: 3,500€) [1]
- PHEV (with Gasoline E5, E10): Chosen vehicles have a higher engine power than stated in assumptions (92 - 95 kW ICE + 60 - 70 kW electric) [2]
- PHEV (with Diesel B7): Chosen vehicle has higher engine power than stated in assumptions (143 kW ICE + 90 kW electric) [4]

CONSIDERED VEHICLES FOR VEHICLE PURCHASE PRICES (F.3):

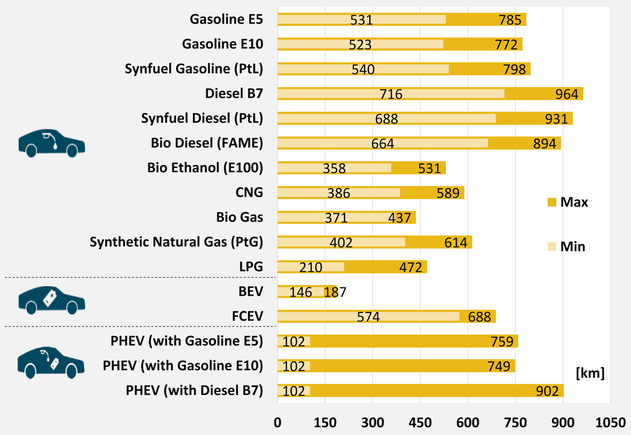
• *Gasoline (E5, E10, Synfuel Gasoline (PtL)):*	Dacia Lodgy TCe 130 GPF Comfort, Opel Grandland X 1.2 DI Turbo Ultimate Automatik
• *Diesel (B7, Bio Diesel (FAME, Synfuel Diesel (PtL)):*	Opel Astra 1.5 Diesel Business Edition, Peugeot 3008 1.5 BlueHDi 130 GT Pack EAT8
• *Bio Ethanol (E100):*	Renault (Dacia) Logan Zen (Brasilien), BMW X2 sDrive18i GP
• *CNG (incl. Bio Gas, Synthetic Natural Gas (PtG)):*	Audi A3 Sportback 30 g-tron S tronic, Audi A3 Sportback 30 g-tron edition one S tronic
• *BEV:*	KIA e-Niro (39,2 kWh) Edition 7, Hyundai IONIQ Elektro Prime
• *FCEV:*	Toyota Mirai II, Toyota Mirai I
• *PHEV (with Gasoline E5, E10):*	MINI Countryman Cooper S E ALL4 Steptronic, Volvo XC40 Recharge T4 R Design Expression DKG
• *PHEV (with Diesel B7):*	Mercedes C300 de Avantgarde 9G-TRONIC

GENERAL ASSUMPTIONS ([8] – [10]):

• *Year (unless otherwise stated):*	2020	• *Battery weight (if applicable):*	154 kg (BEV), 146 kg (PHEV)
• *Vehicle use area:*	Germany / Europe	• *Battery capacity (lithium-ion):*	24.7 kWh (BEV), 20.8 kWh (PHEV)
• *Vehicle type / curb weight:*	Light-duty vehicles (1.20 t (Gasoline), 1.26 t (Diesel), 1.30 t (PHEV), 1.21 t (BEV))	• *Testing standard:*	Worldwide Harmonized Light Vehicles Test Procedure (WLTP)
• *Vehicle class:*	C-segment, 5 seater sedan	• *Electricity mix:*	EU conventional mix 2016, 100% renewable (wind turbine)
• *Engine power:*	90 kW (DICI-ICEV), 98 kW (DISI-ICEV) 85 kW (BEV), 78 kW ICE + 50 kW electric (DISI-PHEV), 82 kW ICE + 50 kW electric (DICI-PHEV)		

OTHER CHARACTERISTICS

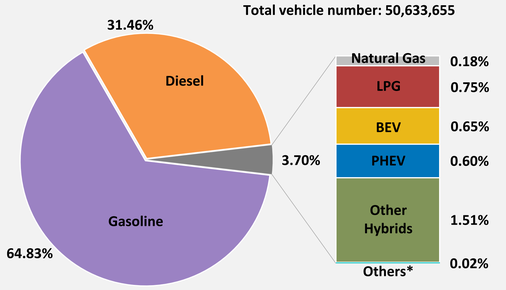
RANGE (F.5)



(F.5): - References: [1], [8] - [10]
- LPG: minimum fuel tank capacity is assumed to be 40 liters [1] while the maximum tank capacity is assumed to be 60 liters [8]; tank can be filled up to 80% [1]
- PHEV: Minimum range value represents only electric mileage
- PHEV: Maximum range calculated with PHEV fuel tank capacity and electric mileage
- Additional notes: see (F.1, F.2)

(F.5): Formula: Range [km] = Fuel Tank or Battery Capacity[X] × $\frac{\mathrm{Energy\ Density}\left[\frac{\mathrm{MJ}}{\mathrm{X}}\right]}{\mathrm{TTW\ Energy\ Consumption}\left[\frac{\mathrm{MJ}}{100\ \mathrm{km}}\right]}$; X in l, kg or kWh ([8])

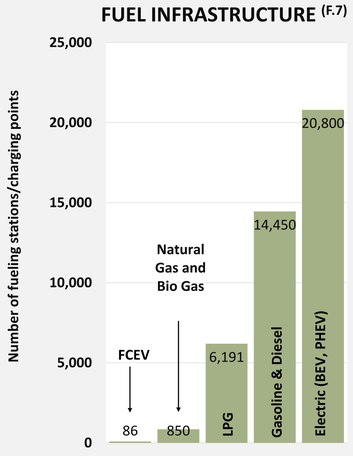
MARKET SHARE (F.6)



* includes FCEV (507 vehicles, 0.001%)

(F.6) References: [17] - [20]

FUEL INFRASTRUCTURE (F.7)



(F.7): References: [13], [21], [25] – [27]

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