## ***Non-paper on Cars/Vans $CO_2$ Regulation proposal: Additional assessment of higher ambition levels for the targets and ZLEV benchmarks***

*Introduction*

This non-paper complements the Impact Assessment accompanying the legislative proposal setting $CO_2$ standards for cars and vans post-2020. It analyses the impacts of additional scenarios[1] using the same methodological approach as in the Impact Assessment.

The assumptions made for the target levels and the incentive for zero- and low-emisison vehicles (ZLEV) for cars and vans under the additional scenarios considered in this non-paper are summarised in the table below.

| **Scenario** | **CO2 Targets** | | **ZLEV Incentive[2]** | | |
|---|---|---|---|---|---|
| | **2025** | **2030** | **Type** | **Mandate/Benchmark level** | |
| | | | | **2025** | **2030** |
| 45%_40%ZLEV | 20% | 45% | Two-way crediting system | 20% | 40% |
| 50%_30%ZLEV | 25% | 50% | Two-way crediting system | 15% | 30% |
| 50%_50%ZLEV | 25% | 50% | Two-way crediting system | 25% | 50% |
| 75%[3] | 45% | 75% | ZEV Mandate | 15% | - |

Table 1: Targets and ZLEV incentives levels in the additional scenarios

*Fleet composition*

The table below provides the projected market shares of ZLEV in 2030 in the new cars fleet under the different scenarios.

| **Projected market shares in 2030 in the new cars fleet** | | | | |
|---|---|---|---|---|
| Scenario | Plug-in hybrid vehicles (PHEV) | Battery Electric Vehicles (BEV) | Fuel Cell vehicles (FCEV) | **Total ZLEV** |
| 30% | 11% | 7% | 2% | **20%** |
| 40% | 16% | 10% | 2.5% | **29%** |
| 45%_40%ZLEV | 22% | 23% | 5% | **50%** |
| 50% | 22% | 13% | 3% | **38%** |
| 50%_30%ZLEV | 13% | 18% | 5% | **36%** |
| 50%_50%ZLEV | 4% | 43% | 5% | **52%** |
| 75% | 29% | 45% | 9% | **83%** |

Table 2: Projected market shares in 2030 in the new cars fleet

[1] The non-paper presents the results of these additional scenarios together with the results of scenarios already analysed in the Impact Assessment, i.e. Scenarios 30%, 40% and 50%

[2] The definition and the accounting rule for ZLEV are as in the Commission proposal, except for scenario 75% where a mandate is set for zero-emission vehicles only

[3] Scenario 75% also assumes that the target is set at 0 g $CO_2$/km starting from 2035

As illustrated in the table above, in the case of more ambitious targets and benchmark levels, the shares of ZLEV in the 2030 new car fleet would increase drastically compared to 2017 (1% ZLEV). Higher benchmark levels lead to a shift towards more BEV at the expense of PHEV in the case of the 50% benchmark with BEV reaching a 43% market share of new cars in 2030, i.e. 6 times higher than in case of a 30% target without ZLEV benchmark.

As shown in the table below, the projected number of new ZLEV registrations in 2030 increases significantly under the different scenarios with respect to 2017, when around 96,000 BEV and 120,000 PHEV were newly registered[4].

| Projected number of newly registered ZLEV in 2030 (thousands of cars) | | | | |
|---|---|---|---|---|
| Scenario | Plug-in hybrid vehicles (PHEV) | Battery Electric Vehicles (BEV) | Fuel Cell vehicles (FCEV) | **Total ZLEV)** |
| 30% | 2,162 | 1,420 | 380 | 3,962 |
| 40% | 3,157 | 1,962 | 514 | 5,633 |
| 45%_40%ZLEV | 4,266 | 4,468 | 1,166 | 9,900 |
| 50% | 4,440 | 2,607 | 671 | 7,718 |
| 50%_30%ZLEV | 2,703 | 3,567 | 1,066 | 7,336 |
| 50%_50%ZLEV | 677 | 8,287 | 1,046 | 10,010 |
| 75% | 5,836 | 8,930 | 1,762 | 16,528 |

Table 3: Projected number of newly registered ZLEV in 2030

As shown in the table below, the projected absolute number of ZLEV in the **total car stock** in 2030 also represents a significant increase with respect to 2017 (around 300,000 BEV and 370,000 PHEV[5]). The projected number of ZLEV ranges between around 30 million vehicles in circulation under a 30% scenario up to nearly 100 million vehicles under the most ambitious scenario.

| Projected number of ZLEV in the stock of cars in 2030 (thousands of cars) | | | | |
|---|---|---|---|---|
| Scenario | Plug-in hybrid vehicles (PHEV) | Battery Electric Vehicles (BEV) | Fuel Cell vehicles (FCEV) | **Total Zero and Low Emission Vehicles (ZLEV)** |
| 30% | 16,494 | 9,780 | 2,762 | 29,036 |
| 40% | 21,331 | 12,256 | 3,607 | 37,194 |
| 45%_40%ZLEV | 35,906 | 27,086 | 7,838 | 70,830 |
| 50% | 27,584 | 15,394 | 4,615 | 47,593 |
| 50%_30%ZLEV | 29,008 | 23,481 | 7,811 | 60,300 |
| 50%_50%ZLEV | 10,768 | 49,499 | 8,040 | 68,307 |
| 75% | 61,035 | 27,158 | 7,840 | 96,033 |

Table 4: Projected number of ZLEV in the stock of cars in 2030

[4] Source: European Alternative Fuels Observatory (EAFO) : http://www.eafo.eu/eu#summary_anchor
[5] Idem

*Recharging and refuelling infrastructure*

The number of ZLEVs on the market will inevitaby influence the speed of deployment of charging stations, which ultimatively have to be deployed anyway to decarbonise the transport sector. Assuming that one public charging point is necessary per 10 electric cars (BEV and PHEV), the number of public charging points required in 2030 would range between 2.6 million under the 30% scenario and 8.8 million for the most ambitious scenario. This represents an increase by a factor 20 to 75 compared to the 120,000 publically available charging points currently available in the EU[6] .

This estimate does not capture further developments in battery capacity and recharging speed, nor scale effects as it assumes a constant ratio between the number of cars and the corresponding number of public charging points required. Both battery capacity and recharging speeds will reduce the number of necessary charging points. Nevertheless, it gives an indication of the additional effort needed with respect to the current situation.

The abovementioned figures do not include the necessary hydrogen refilling stations. These will require a substantial increase of the currently available stations to be able to cover the needs of the projected 2.8 million fuel cell vehicles under a 30% scenario and 8 million vehicles under the most ambitious scenario. Today only few hydrogen refilling stations exist in the EU[7].

| **Projected number of EV and number of public electric charging points in 2030 (thousands)** | | | | |
|---|---|---|---|---|
| Scenario | Plug-in hybrid vehicles (PHEV) | Battery Electric Vehicles (BEV) | Total PHEV + BEV | **Number of public charging points (thousands)** |
| 30% | 16,494 | 9,780 | 26,274 | 2,627 |
| 40% | 21,331 | 12,256 | 33,587 | 3,359 |
| 45%_40%ZLEV | 35,906 | 27,086 | 62,992 | 6,299 |
| 50% | 27,584 | 15,394 | 42,978 | 4,298 |
| 50%_30%ZLEV | 29,008 | 23,481 | 52,489 | 5,249 |
| 50%_50%ZLEV | 10,768 | 49,499 | 60,267 | 6,027 |
| 75% | 61,035 | 27,158 | 88,193 | 8,819 |

Table 5: 2030 Projected number of EV and number of public electric charging points

The investments required for developing the necessary recharging and refuelling infrastructure (electricity and hydrogen), both private and public charging points, are estimated in the table below for the different scenarios. They are expressed as cumulative annualised costs over the period 2020-2040.[8]

[6] http://www.eafo.eu/electric-vehicle-charging-infrastructure

[7] See http://www.eafo.eu/infrastructure-statistics/hydrogen-filling-stations - The data are currently under review and will be updated soon

[8] The calculations for BEV and PHEV are based on the assumption of 1 private charging point for each vehicle, and 0.1 public charging points for each vehicle; actual ratios are likely to differ depending on the type of charging (slow or fast), developments in battery and charging technology, and scale effects. For hydrogen refuelling, country specific utilisation rates are assumed (cars serviced per filling stations), which progressively

| Recharging/refuelling infrastructure investments - cumulative annualised costs 2020-2040 (million euro) | | |
|---|---|---|
| Scenario | Total cost | Difference compared to the baseline |
| Baseline | 50,329 | 0 |
| 30% | 81,479 | 31,150 |
| 40% | 102,534 | 52,205 |
| 45%_40%ZLEV | 162,890 | 112,561 |
| 50% | 130,100 | 79,771 |
| 50%_30%ZLEV | 142,219 | 91,890 |
| 50%_50%ZLEV | 161,918 | 111,589 |
| 75% | 241,613 | 191,284 |

Table 6: Investment costs in recharging/refuelling infrastructure

*Economic impacts*

Following the same methodological approach as in the Impact Assessment, the direct economic impacts have been assessed by considering the net changes (i.e. changes compared to the baseline) in capital costs, fuel costs, and operating and maintenance (O&M) costs for an "average" new car[9], registered in 2030.

For the analysis of the economic impacts, as in the Impact Assessment, the following indicators were used[10]:

- Net economic savings over the vehicle lifetime from a societal perspective

  This parameter reflects the change in costs over the lifetime of 15 years of an "average" new vehicle without considering taxes and using a discount rate of 4%.

- Net economic savings from a consumer perspective

  This parameter reflects the change in costs over the lifetime of 15 years of an "average" new vehicle. In this case, given the end-user perspective, taxes are included and a discount rate of 11% is used.

From a societal perspective, a 30% target and to a lesser extent a 40% target, lead to net economic savings for a new 2030 average car. Higher ambition levels lead to net economic costs.

increase to conventional petrol filling stations utilisation/service ratios. Cost assumptions are based on the ASSET project: https://ec.europa.eu/energy/sites/ener/files/documents/2018_06_27_technology_pathways_-_finalreportmain2.pdf

Both in the baseline and other scenarios, the investment costs for the electricity recharging and hydrogen refueling infrastructure are calculated in the analysis as annuity payments for capital, with a discount rate of 8%. The cumulative costs in the period 2020-2040 are therefore presented, to capture the impact of the 2030 investments.

[9] An "average" new vehicle of a given year is defined by averaging the contributions of the different segments of small, medium, large vehicles and powertrains by weighting them according to their market penetration as projected. For more information, see Commission Staff Working Document SWD(2017) 650 final

[10] For more information, see Commission Staff Working Document SWD(2017) 650 final

This effect is explained by the significant increase of the additional upfront costs for an "average new car" under the more ambitious scenarios assuming that consumer preference remain identical.

The analysis shows that the economic impacts depend on the combination of the target and the ZLEV benchmark levels, which drives the composition of the fleet of new vehicles in terms of powertrains and segments. Of course the decision of buying a car is not rational and heavily influenced by the marketing strategy of OEMs. High ZLEV benchmark levels for a given target may lead to an increase in the net economic costs, both from a societal and consumer perspective. This is particularly evident in the scenario 45%_40%ZLEV 50%_50%ZLEV, where an increased share larger conventional vehicles may be observed, with negative impacts on the net savings. With the increased penetration of ZLEV driven by the high benchmark level, less effort will be needed in improving the efficiency of the conventional vehicles to meet the proposed fleet-wide $CO_2$ target. This results in a projected shift towards larger segments for conventional vehicles leading to an increase in the costs.

| ***Net economic savings (+) or net economic costs (-) per new 2030 average car*** | | |
|---|---|---|
| Scenario | Societal perspective | Consumer perspective |
| 30% | +800 € | +1,400 € |
| 40% | +560 € | +1,000 € |
| 45%_40%ZLEV | -1,450 € | - 1,050 € |
| 50% | -2 € | +390 € |
| 50%_30%ZLEV | - 40 € | +400 € |
| 50%_50%ZLEV | -800 € | -200 € |
| 75% | -1,200 € | -430 € |

Table 7: Net economic savings or net economic costs per new 2030 average car

Furthermore, the net economic costs of the 45%_40%ZLEV scenario are projected to be higher compared to the scenario 50%_50%ZLEV as a higher PHEV share is projected in comparison with BEV, leading to relatively lower fuel savings. This higher share of PHEV is observed in particular in the smaller segments of the market leading to higher manufacturing costs compared to other powertrains in the same segment.

The net economic costs of the 45%_40%ZLEV scenario are also projected to be higher compared to the 75% scenario as the increase in manufacturing costs is higher in the 75% scenario but the increase in fuel savings is even higher.

<u>*Employment impacts*</u>

The same modelling approach as for the Impact Assessment has been used to analyse the employment impacts of the additional scenarios. From a macro-economic perspective, target levels incentivising ZLEV lead to small positive impacts in terms of overall employment. Increased consumer expenditure, increased investment in infrastructure, reduction of oil imports, and expansion in the battery sector in the EU are all positive drivers for total jobs creation. Reduction of air pollution and related economic benefits of lower loss of GDP due to health and lost working days is not factored in this calculation.

The projected increase in overall EU-28 employment in 2030, compared to a 'business as usual' scenario, is shown in the table below. This takes account of the targets set for both cars and vans. For each scenario, results are presented for two variants: (1) assuming that batteries for electric vehicles are imported from outside of the EU, and (2) assuming that they are produced in the EU. The change in employment does not only include direct effects, but also second-order effects in sectors of the economy benefitting from increased consumer expenditures for goods and services with a high domestic content due to consumers' savings from lower fuel bills. None of the analysed scenarios include the risk of the so-called Kodak moment, i.e. when consumers opt for a new product from outside the EU.

| **Total EU employment in 2030 (compared to baseline)** | | | | |
|---|---|---|---|---|
| **Scenario** | **batteries imported** | | **batteries produced in EU** | |
| Baseline (thousands) | 230,207 | | 230,233 | |
| | Percentage additional jobs | Additional number of jobs (thousands) | Percentage additional jobs | Additional number of jobs (thousands) |
| 30% | 0.02% | 46 | 0.03% | 69 |
| 40% | 0.03% | 69 | 0.04% | 92 |
| 45%_40%ZLEV | 0.02% | 47 | 0.07% | 151 |
| 50% | 0.02% | 51 | 0.04% | 101 |
| 50%_30%ZLEV | 0.02% | 56 | 0.06% | 145 |
| 50%_50%ZLEV | 0.01% | 20 | 0.07% | 154 |
| 75% | 0.03% | 69 | 0.1% | 221 |

Table 8: Total EU employment in 2030

The transition towards zero-emission mobility also leads to differences between individual sectors. The overall employment increases up to 69,000 and 221,000 in the 75% target scenario (in the variants assuming batteries are imported and batteries are produced in the EU respectively) in 2030 compared to the baseline. To the contrary, existing jobs (related to combustion engine) risk being lost in the automotive sector if the transition is too fast, as illustrated in the table below.

| Job losses in the automotive sector in 2030 (compared to baseline) | | |
|---|---|---|
| **Scenario** | Absolute number of jobs (thousands) | Percentage |
| 30% | -2 | -0.1% |
| 40% | -12 | -0.5% |
| 45%_40%ZLEV | -59 | -2.4% |
| 50% | -26 | -1% |
| 50%_30%ZLEV | -46 | -2% |
| 50%_50%ZLEV | -85 | -3.5% |
| 75% | -92 | -3.7% |

Table 9: Employment in 2030 in the automotive sector in the EU

The table above shows the projected job losses in the automotive sector in 2030, compared to a 'business as usual' scenario[11]. The projections assume that between the baseline and the different scenarios there is no further automation of production, no loss of market shares to new EV models from 3rd countries. With these assumptions a 30% target leads to a gradual transition to ZLEV with a nearly stable number of jobs in the automotive sector because a high number of plug-in hybrids continues to be produced in the existing factories and the share of pure battery electric cars stays below a 10% market share in 2030. In the scenarios with higher targets leading to a rapid increase of BEV market penetration, job losses are observed for the automotive sector.

*Greenhouse gas emissions*

The figure below shows the projected $CO_2$ emissions in road transport under the different scenarios. Scenarios with a stricter target level yield more emission reductions.

Under the baseline, greenhouse gas emissions in road transport reduce by around 17% between 2005 and 2030. Under the EUCO30[12] scenario, emissions from road transport are projected to reduce by 25% in 2030 with respect to 2005, as a result of the implementation of a full set of additional policies with respect to the baseline.

A 30% target, as proposed by the Commission, is projected to lead to a reduction of 21-22%. The reduction levels increase up to around 26-27% for a 50% target, and up to 35% for a 75% target.

[11] The projections assume that between the baseline and the different scenarios there is no further automation of production, no loss of market shares to new EV models from 3rd countries.
[12] The EUCO30 scenario underpinned the analytical work carried out to support the Effort Sharing Regulation Proposal.

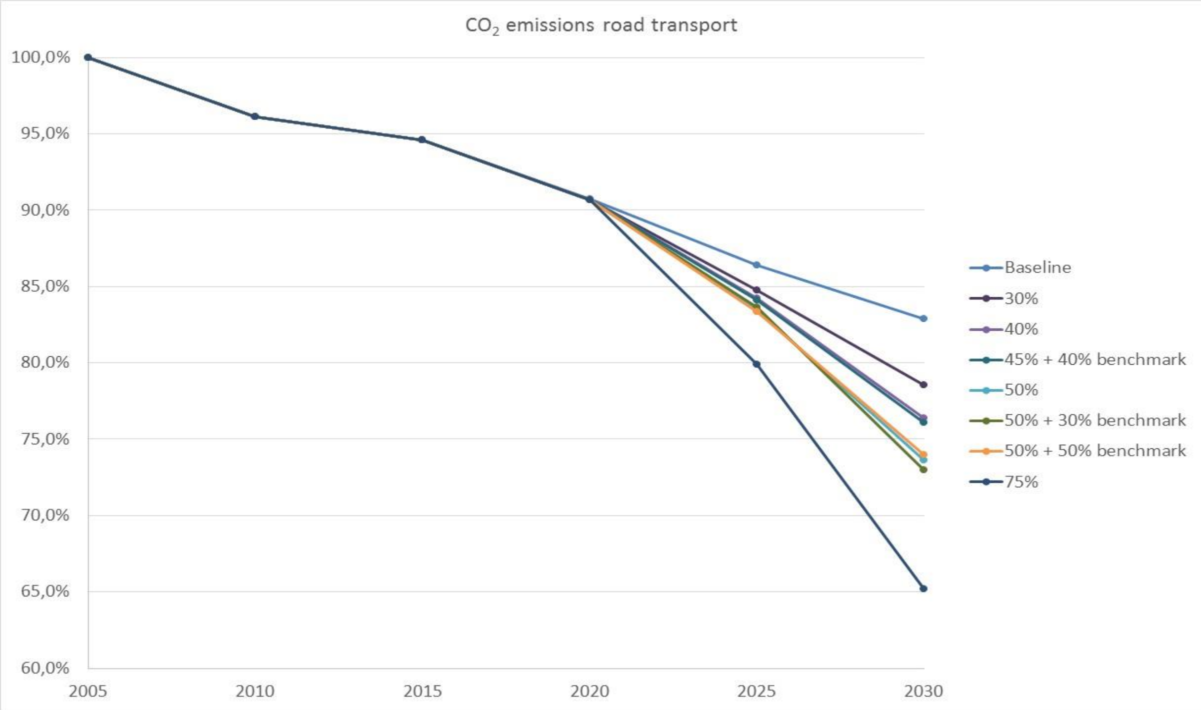

Figure 1: CO2 projections in road transport

*Air pollutant emissions*

Due to the change in fleet composition under the different scenarios, also the emissions of air pollutants are affected. With a 30% target, the $NO_x$ emissions from road transport in 2030 are projected to be 40% lower than in 2020. With increasing targets and benchmark levels, the reduction is higher, ranging from 42% to 52%. Concerning $PM_{2,5}$, a 30% target leads to a 32% emission reduction in 2030 compared to 2020. With increasing targets and benchmark levels, the reduction goes up to, ranging from 36% to 53%.

*Battery market*

As illustrated in the table below, the post-2020 $CO_2$ standards for cars and vans are of key importance in determining the pace of EV battery demand growth in the EU, as this depends on the market uptake of electric and plug-in hybrid vehicles.

| Scenario | EU minimum EV battery demand **in 2025** (GWh/year) |
|---|---|
| 30% | 66 |
| 40% | 100 |
| 50% | 130 |

Battery cell production can be located close to end markets as car manufacturers have just-in-time supply chains and prefer suppliers close to their factories. By supporting industry-led projects to build an innovative, sustainable and competitive battery value chain in Europe, the EU Battery Alliance is facilitating key investments in battery cells, and ensures Europe remains a global centre for automotive manufacturing.

A key risk is the potential dependency on production of batteries outside Europe, and possibly issues related to security of battery supply and costs. Key raw materials like Cobalt or Graphite are e.g.currently concentrated in a few countries outside Europe.

Within this context, recovery and recycling of raw materials becomes important and offers new business opportunities.[13] Already today, more recycling of end-of-life batteries in consumer electronics could provide substantrial amounts of secondary raw materials for new batteries.

However, given the recent introduction of EVs on the European market, and taking into account the average lifetime of EV components, a significant number of EVs have not yet reached end-of-life.

Under current circumstances, the EU recycling infra-structure targeting EV batteries should still be adapted to the expected increase of EV battery flows and to recover specific materials. Large-scale recycling of EV batteries is not expected before 2020 and should only be more effective beyond 2025.

Further research and development is also required to address technological and economic challenges related to the more efficient use, recovery and recycling of EV batteries.

As part of its strategic action plan for batteries[14], the Commission has therefore adopted a set of concrete measures with sustainability requirements and circularity at its core - ranging from research and innovation, to raw materials policy, sustainable processing and production, second use and recycling.

Sensitivity – higher battery costs

To take into account the risk that higher battery material prices would counter projected cost reductions in batteries associated with economies of scale, a sensitivity analysis was conducted on one scenario, assuming no reduction of battery prices would occur with respect to the baseline. In this case, higher net economic costs are observed for an average car, both from a societal and consumer perspective, as presented in the table below.

| ***Net economic savings per new 2030 average car (EUR)*** | | |
|---|---|---|
| Scenario | Societal perspective | Consumer perspective |
| 50%_50%ZLEV | -800 € | -200 € |
| 50%_50%ZLEV (high battery costs) | -2250 € | -1950 € |

[14] COM(2018) 293 final