Concawe's response to the publication and presentation of T&E's report[1] "Magic green fuels: Why synthetic fuels in cars will not solve Europe's pollution problems?"

T&E published a report on Monday 6 December, presenting their interpretation of the results of the lab tests they commissioned to IFPEN to measure air pollutant emissions of e-petrol in cars. Concawe, the refining industry's scientific and technical body, has expertise on vehicles emissions and published several peer-reviewed articles in recognized scientific journals and conferences[2][3][4]. We conducted a thorough analysis of the scientific and technical content of the reports and concluded that on a strict science-based approach some aspects such as E-fuel composition, Emissions and Climate Neutrality would have benefitted from a more cautious analysis and interpretation. While IFPEN report[5] has a real scientific value, being balanced and contextualized (for instance, the first sentence of IFPEN executive summary is "With no exception, this experimental campaign shows that the vehicle complies with the normative thresholds"), we regret some cherry-picking of results in T&E's report and the fact that these are then put out of context. This inevitably leads to flawed conclusions and misleading statements.

Concawe want therefore to share the following analysis in reaction to the publication of the T&E report.

- **"E-petrol" composition**:
  - **The so-called "e-petrol" fuels evaluated by T&E are in fact out-of-specs petroleum fuels**. T&E failed to procure fuels from renewable sources, and the tested fuels are in fact gasoline blends made of different non-renewable solvents[6]. Furthermore, these fuels are not even synthetic ones. This raises serious concerns about the representativeness of such fuels for an "e-petrol" study. Furthermore, Concawe want to stress that T&E's study focused on a specific type of fuel, having a paraffinic composition. In the future (as it is the case today), synthetic fuels will have to comply with the gasoline specifications in Europe (called EN228) and will have similar chemical structure as today. As an example, the most mature e-petrol today is e-M-t-G (e-Methanol-to-Gasoline), which has a very different composition than the fuels evaluated by T&E.
  - **The tested "e-petrol" are out of specifications** (EN228). This is an important information which is omitted from T&E's report. It is therefore very surprising that T&E's report states that the fuels "are compatible with the EU EN228 fuel specification and have good combustion properties in order to ensure existing fleet capability"[7]. This is not correct following IFPEN report[8]: for example,

[1] https://www.transportenvironment.org/wp-content/uploads/2021/11/2021_12_TE_e-fuels_cars_pollution.pdf
[2] Williams, R., Dauphin, R., Andersson, J., Ziman, P. et al., "Fuel Effects on Regulated and Unregulated Emissions from Three Light-Duty Euro 5 and Euro 6 Diesel Passenger Cars," SAE Technical Paper 2020-01-2147, 2020, doi:10.4271/2020-01-2147.
[3] Williams, R.; Pettinen, R.;Ziman, P.; Kar, K.; Dauphin, R. FuelEffects on Regulated and Unregulated Emissions from Two Commercial Euro V and Euro VI Road TransportVehicles.Sustainability2021,13, 7985.https://doi.org/10.3390/su13147985
[4] Demuynck, J.; Dauphin, R.;Yugo, M.; Mendoza Villafuerte, P.;Bosteels, D. Advanced Emission Controls and Sustainable Renewable Fuels for Low Pollutant and CO2Emissions on a Diesel Passenger Car.Sustainability2021,13, 12711.https://doi.org/10.3390/su132212711
[5] https://www.transportenvironment.org/wp-content/uploads/2021/12/2021_12_IFPEN_test_results.pdf
[6] IFPEN report, previously mentioned, p. 7. The solvents are "a mixture of light aromatics (< C8) and C5-C8 hydrocarbons including linear, branched alkane such as isopentane, isooctane and alkene such as diisobutylene".
[7] T&E report, previously mentioned, p. 15.
[8] IFPEN report, previously mentioned, p.8-9.

one of the tested fuels would be overly volatile (half evaporated at 53°C, and 73% evaporated at 70°C versus a limit of 52% evaporated at 70°C according to the EN228 gasoline specification). Driving a vehicle with such a fuel in summer time in Southern Europe would raise serious safety concerns, because of potential hydrocarbon emissions from the fuel tank, and is unlikely to be accepted by both public authorities and industry stakeholders. While it is perfectly fine to test out-of-specs fuels for science purpose (Concawe do this on a regular basis too), extrapolating the results, potentially for a legislative purpose, without the context that T&E failed to mention, is scientifically unacceptable.

- Using excessively volatile petrol can lead to unmanaged mixture preparation in the combustion chamber, potentially resulting in unmanaged engine emissions. Nevertheless, the tested fuels showed emissions largely complying with the latest Euro 6d standards, and potentially already compliant with the forthcoming Euro 7 standards (see item on emissions below). Instead of being criticized, these results should be recognized as remarkable, as they show the robustness of the vehicle's emissions control system to "unconventional" testing conditions.

- **Emissions** (measured in T&E's study)**:**
  - **NOx** (nitrogen oxides) emissions are 60% below the Euro 6d limits in real driving conditions, and already comply with the very stringent levels proposed for Euro 7 by the CLOVE consortium (although under Euro 6 testing conditions). This shows ultra-low NOx emissions.
  - The **CO** (carbon monoxide) emissions when using the T&E so-called "e-petrol" are already 55% lower than the levels proposed for Euro 7 by the CLOVE consortium on a WLTC and 85% lower on a RDE cycle. This shows ultra-low CO emissions. Compared to the current Euro 6d limits, they are 80% lower on a WLTC and more than 90% lower on a RDE cycle.
  - The **HC** (unburnt hydrocarbons) emissions when using the T&E so-called "e-petrol" are already 60% lower than the levels proposed for Euro 7 by the CLOVE consortium on a WLTC and more than 85% lower on a RDE cycle. This shows ultra-low HC emissions. Compared to the current Euro 6d limits, they are more than 80% lower on a WLTC and 95% lower on a RDE cycle.
  - **PN** (particulates number) emissions are between 10 times and 500 times lower than Euro 6d limits. These particles emissions levels remain well below the non-exhaust emissions, e.g. from tyre and brake wear[9]. Road transport only contributes to 10% of total PM 2.5 emissions in Europe[10]. Reducing PM emissions requires measures targeted towards the biggest emitters, e.g. domestic heating. Today's non-regulated PN 10 nm measured levels already comply with the most stringent Euro 7 proposal.
  - Although **NH_3** (ammonia) emissions are not yet regulated, the measured levels are already 80% lower than the proposed levels for Euro 7 on a WLTC, and at least 40% lower on a RDE cycle. As 94% of total ammonia emissions in Europe come from the agricultural sector[11], reducing these emissions should require targeted measures.

[9] "Based on recent evidence, average brake wear PM10 emission level for conventional vehicles are confirmed at ~12 mg/km (depending on national conditions) for the average passenger car in urban conditions. […] This corresponds to 30-50 times exhaust emission levels from Euro 6d cars. […] [Tyre wear emissions are of] similar order of magnitude to brake wear". Source "Non-exhaust emissions: evaporation & break wear control", CLOVE, online AGVES meeting, 8th April 2021.
[10] https://www.eea.europa.eu/publications/air-quality-in-europe-2021/sources-and-emissions-of-air
[11] Id.

	WLTC measurements						Compliance with standards	
	NOx [mg/km]	CO [mg/km]	HC [mg/km]	NH3 [mg/km]	PN 23 nm [#/km]	PN 10 nm [#/km]	Euro 6d	Proposed Euro 7
Euro 6d standard limits	60	1000	100	-	6E+11	-		
Euro 7 proposed limits	30	400	45	10	-	1E+11		
Measurements: E10	24	70	17	0.9	5.2E+10	8.8E+10		
Measurements: most emitting "e-petrol"	23	182	13	2	1.3E+09	2.9E+09		
% below Euro 6d standards: E10	-60%	-93%	-83%	-	-91%	-	**YES**	
% below Euro 6d standards: most emitting "e-petrol"	-62%	-82%	-87%	-	-100%	-	**YES**	
% below proposed Euro 7 standards: E10	-20%	-83%	-62%	-91%	-	-12%		**YES**
% below proposed Euro 7 standards: most emitting "e-petrol"	-23%	-55%	-71%	-80%	-	-97%		**YES**

Figure 1 : Summary of emissions measured in T&E's study on a WLTC, and comparison with Euro 6d standard limits and Euro 7 proposed limits[12].

	RDE cycle measurements						Compliance with standards	
	NOx [mg/km]	CO [mg/km]	HC [mg/km]	NH3 [mg/km]	PN 23 nm [#/km]	PN 10 nm [#/km]	Euro 6d	Proposed Euro 7
Euro 6d standard limits	85.8	1000	100	-	9E+11	-		
Euro 7 proposed limits	30	400	45	10	-	1E+11		
Measurements: E10	21	37	5	2.7	1.9E+10	4.1E+10		
Measurements: most emitting "e-petrol"	22	56	4	5.8	3.3E+09	7.8E+09		
% below Euro 6d standards: E10	-76%	-96%	-95%	-	-98%	-	**YES**	
% below Euro 6d standards: most emitting "e-petrol"	-74%	-94%	-96%	-	-100%	-	**YES**	
% below proposed Euro 7 standards: E10	-30%	-91%	-89%	-73%	-	-59%		**YES**
% below proposed Euro 7 standards: most emitting "e-petrol"	-27%	-86%	-91%	-42%	-	-92%		**YES**

Figure 2 : Summary of emissions measured in T&E's study on a RDE cycle, and comparison with Euro 6d standard limits and Euro 7 proposed limits.

- **Emissions** (measured in Concawe's studies)
  - Concawe performed 4 studies using renewable Diesel (100% renewable HVO) and synthetic petrol (100% renewable synthetic E20), with vehicles ranging from Euro 5 to Euro 6d (3 of them have their results published[13] in peer-reviewed papers, and one is still ongoing). For any of these studies, the conclusions remained the same:
    - **There is no significant effect of the tested renewable fuels on pollutants emissions from latest (Euro 6/VI) passenger cars and heavy duty vehicles (vs. regular fuels);**
    - **The Euro 6 vehicles tested with renewable fuels remain compliant with Euro 6 standards;**
    - In older technology vehicles (Euro 5/V), paraffinic diesel fuels reduce particulate mass and NOx emissions.
  - In its report, T&E repeatedly refer to a Concawe study which would have demonstrated that using e-diesel results in increasing particles emissions[14]. Concawe want to clarify that this is not correct: first, Concawe have never performed any study using e-diesel, and have never pretended to do so; second, with what is the closest representative of Fischer-Tropsch e-diesel, which was in fact a 100% renewable HVO, Concawe never concluded that the particles emissions could increase, and the collected experimental data certainly does not support such a statement. **Concawe kindly ask T&E to stop referring to our studies in a misleading way**.

[12] As proposed by the CLOVE consortium at the last AGVES (Advisory Group on Vehicles Emissions Standards) meeting (27th April 2021)
[13] Published papers, previously mentioned
[14] T&E report, previously mentioned, p.14, 15, 30, 31

- For all fuels in "petrol" and "Diesel" cars, **Euro 6d is a huge improvement compared to Euro 5. For Diesel Euro 6d cars in real driving conditions, NOx emissions are reduced by a factor 10 to 100 compared to Euro 5.**

- **Climate neutrality**:
  - The wording used by T&E on CH_4 and N_2O emissions is misleading and led to unfortunate confusions during the oral intervention of their representative. Concawe want to clarify that, in its studies (to which T&E refer), some N_2O emissions at the tailpipe is indeed observed when using any Diesel or Diesel-like fuels. This is mainly related to the reactions occurring in the after-treatment system and is not specific to synthetic fuels.
  - According to T&E, an average gasoline car running on **e-petrol emits 7-9 kg of CO_2eq a year**. This needs to be compared with the production of a modest 30 kWh battery (driving range of around 200 km in homologation conditions) which leads to the emission of approx. 3000 kg of CO_2eq[15], i.e. **200 kg of CO_2 a year** during a 15-year ownership. This is 20 times more emissions than the CO2 emitted by an e-petrol vehicle according to T&E's report.

- **In conclusion Concawe consider that from a science-based approach**:
  - **The Euro 6d vehicle tested by T&E, either with T&E so-called "e-petrol" or fossil gasoline, shows very low emissions**, at least 50% below the current Euro 6d limits (and up to 500 times lower on some parameters), and already complies with the most stringent limits proposed by the CLOVE consortium for Euro 7 (although under Euro 6 testing conditions).
  - ISC (In-service conformity), MaS (Market Surveillance) and Periodic Technical Inspection (PTI), along with On-Board Diagnostic (OBD) **ensure that vehicles maintain their low emission levels all life long**. These are all mandatory features of Euro 6d standards.
  - **Improving air quality in urban areas requires targeted measures**, e.g. phasing-out old Diesel vehicles (NOx), domestic heating (PM), agriculture (NH_3), etc.
  - **E-fuels produced from renewable electricity can compete with battery electric vehicles on their life-cycle CO_2 emissions**. However, they are far less efficient from an energy point of view. For this reason, we agree that **electrifying journeys, either through BEVs (Battery Electric Vehicles) or PHEVs (Plug-in Hybrid Electric Vehicles), remains the main short-term solution for reducing the carbon footprint of new passenger cars**[16]. **Still, ICE (Internal Combustion Engine) vehicles represent and will represent for the coming decade the vast majority of vehicles on the roads, and renewable low-carbon liquid fuels are an opportunity to reduce the CO_2 emissions of road transport, in addition to the electrification of the fleet. These conclusions are even more important for heavy-duty vehicles where there are significant challenges for full electrification.**

[15] Calculation based on GHG emissions associated with the manufacturing of batteries at 102.7 kg CO2 eq./kWh in 2019. Source: Ternel, Cyprien, Bouter, Anne, Melgar, Joris, 2021. Life cycle assessment of mid-range passenger cars powered by liquid and gaseous biofuels: Comparison with greenhouse gas emissions of electric vehicles and forecast to 2030. Transportation Research Part D: Transport and Environment 97, 102897. https://doi.org/10.1016/j.trd.2021.102897.

[16] Ehsan Shafiei, Roland Dauphin, Marta Yugo, Optimal electrification level of passenger cars in Europe in a battery-constrained future, Transportation Research Part D: Transport and Environment, Volume 102, 2022, 103132, ISSN 1361-9209, https://doi.org/10.1016/j.trd.2021.103132.