



GFEI Workshop on In-use Fuel Economy

Update on the development of the WLTP and its implementation into the EU legislation

London, 16 July 2014

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Summary

- The development of the WLTP
- Implementation into EU legislation – The correlation project
- Conclusions and open points



The WLTP (excerpts from current Technical Regulation, GTR)

In its November 2007 session, WP.29 decided to set up an informal WLTP group under GRPE to prepare a roadmap for the development of the WLTP. After various meetings and intense discussions, WLTP informal group presented in June 2009 a first road map consisting of 3 phases.

The WLTP (...cont...)

- (a) Phase 1 (2009 ÷ 2014): development of the worldwide harmonised light duty driving cycle and associated test procedure for the common measurement of criteria compounds, CO₂, fuel and energy consumption (*Type 1 test of EU type approval procedure*).
- (b) Phase 2 (2014 ÷ 2018): low temperature/high altitude test procedure, durability, in-service conformity, technical requirements for on-board diagnostics (OBD), mobile air-conditioning (MAC) system energy efficiency, off-cycle/real driving emissions.
- (c) Phase 3 (2018+): emission limit values and OBD threshold limits, definition of reference fuels, comparison with regional requirements.

The WLTP (...cont...)

Since the beginning of the WLTP process the European Union had a strong political objective set by its own legislation [Regulation (EC) 443/2009 and Regulation (EU) 510/2011] to implement a new and more realistic test cycle by 2014, which was a major political driving factor for setting the time frame of the whole WLTP and in particular of phase 1.

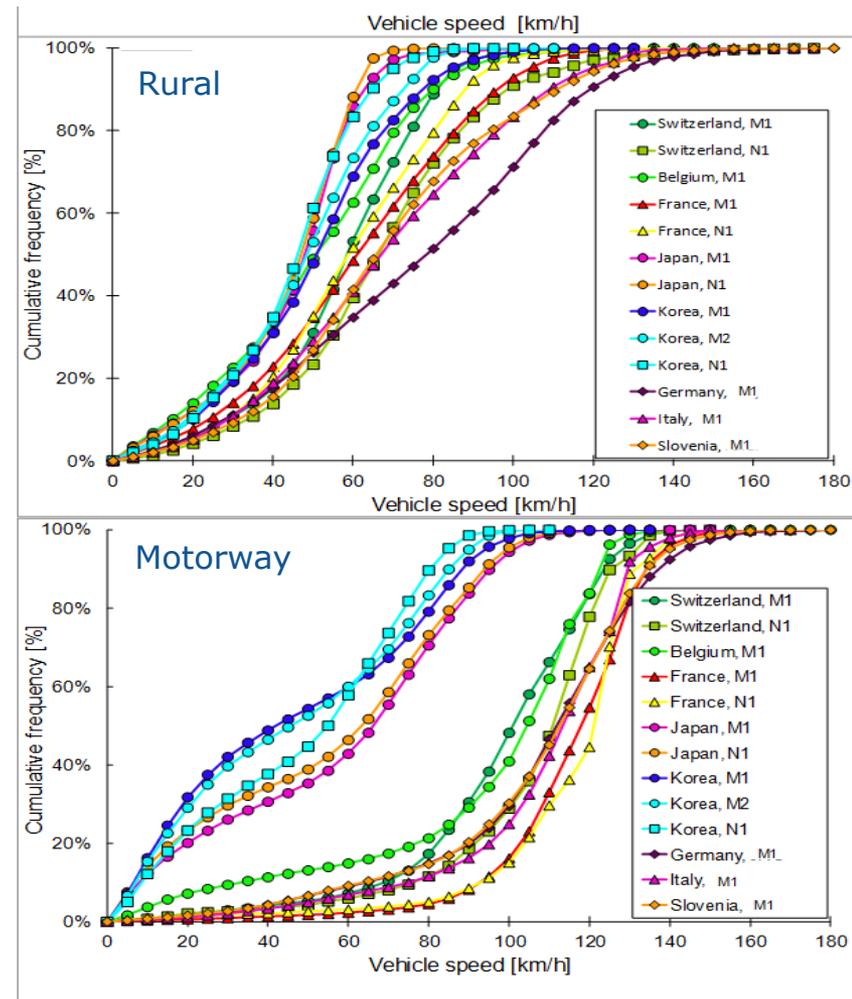
The WLTP (...cont...)

For the work of phase 1 the following working groups were established:

- Development of harmonised cycle (DHC): construction of a new Worldwide Light-duty Test Cycle (WLTC);
- Development of test procedures (DTP): development of test procedures.

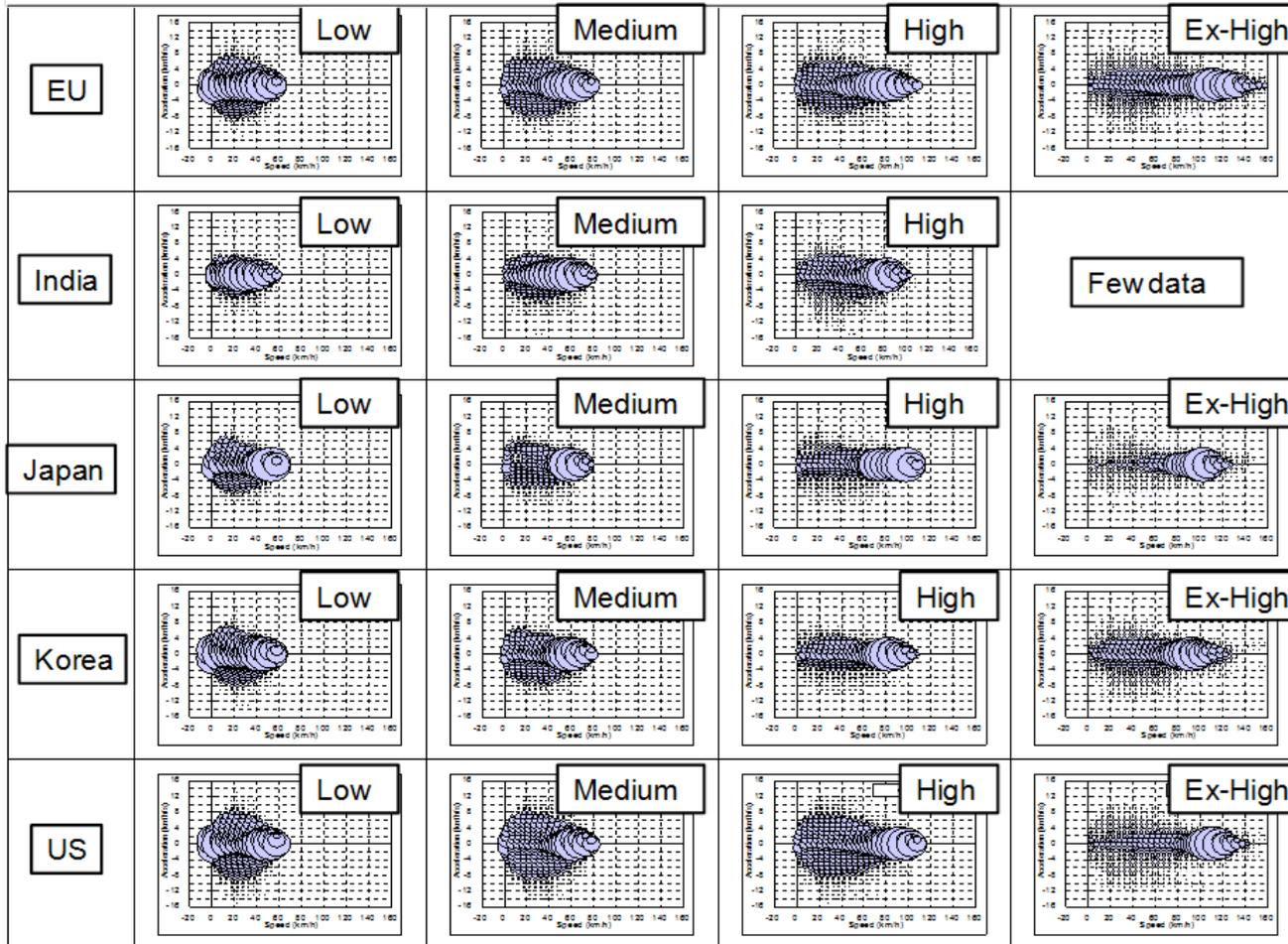
Developing the WLTP-DHC

- The DHC is based on *vehicles' in-use data* collected in the different countries participating into the project
- Clear from the observations that a world-wide harmonization based on the concept of Urban, Rural and Motorway roads was not feasible.
- To solve this problem the WLTP working group decided to move from the Urban, Rural, Motorway approach to the *Low, Medium, High (and extra-High) speed phases*.





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This is the outcome of a series of comparisons to find the speed phase limits that would provide the best results in terms of similarity among the different regional databases. It was found that the best solution was:

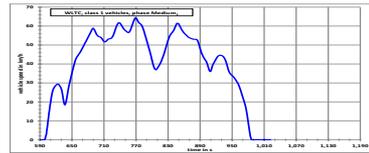
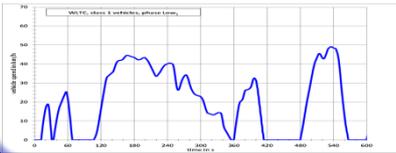
- Low speed < 60 kph
- Medium speed < 80 kph
- High speed < 110 kph
- Ex-High speed > 110 kph



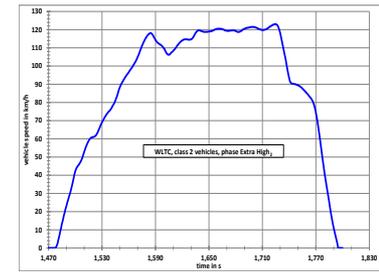
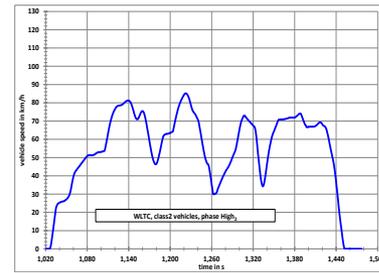
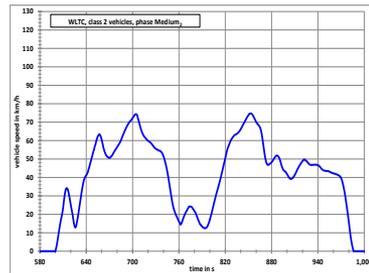
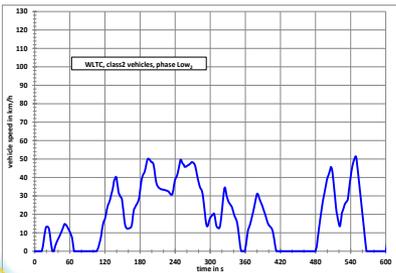
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The WLTP – DHC

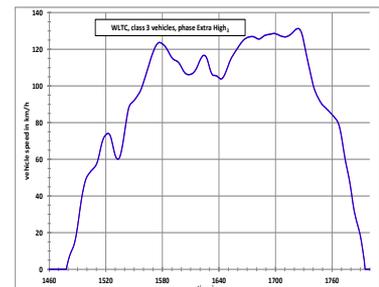
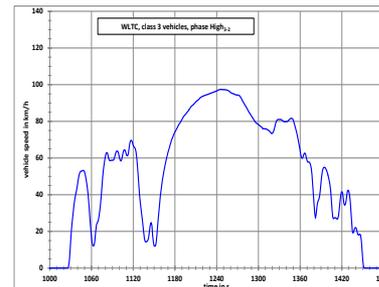
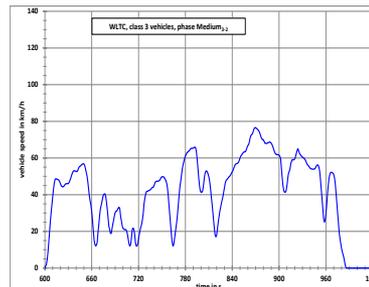
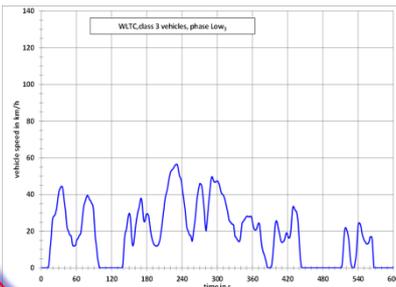
WLTP Class 1



WLTP Class 2



WLTP Class 3.2



The WLTP – DTP

The DTP working group was divided in 5 subgroups:

- PM-PN: Particle mass (PM) and particle number (PN) measurements.
- APM: Additional pollutant measurements, i.e. measurement procedures for exhaust substances which are not regulated yet as compounds but may be regulated in the near future, such as NO₂, ethanol, aldehydes, and ammonia.
- LabProICE: test conditions and measurement procedures of existing regulated compounds for vehicles equipped with internal combustion engines (other than PM and PN).
- EV-HEV: specific test conditions and measurement procedures for electric and hybrid-electric vehicles.
- REF-FUEL: definition of reference fuels.

The WLTP (...cont...)

In order to have the WLTP GTR approved in March 2014, i.e. in time for the development and finalization of the European legislative process, a formal GTR was presented to GRPE in August 2013 for acceptance in November 2013 and submission of the GTR to WP.29 for the official UNECE approval.

However it had become clear that a number of issues, in particular but not only in relation to electric and hybrid-electric vehicles, could not be resolved in time for an adoption of the first version of the WLTP GTR by WP.29 in March 2014.

The WLTP (...cont...)

Thus the concept of Phase 1a and 1b was introduced.

Phase 1a will last until end of 2013 and will be reflected in the GTR version that is going to be approved in March 2014 by WP.29.

Meanwhile, all the remaining issues belonging to phase 1 will be further worked out and agreed during 2014 (phase 1b), with a view to have by the end of that year the complete GTR version, approved and implementable.

The WLTP (...cont...)

Phase 1b

<p>DHC:</p> <ul style="list-style-type: none"> (i) speed violation criteria; (ii) further downscaling in wide open throttle (WOT) operation; (iii) sailing and gear shifting. 	
<p>LabProICE:</p> <ul style="list-style-type: none"> (i) normalization methods, drive trace index; (ii) energy economy rating and absolute speed change rating for speed trace violations; (iii) wind tunnel as alternative method for road load determination; (iv) supplemental test with representative regional temperature and soak period. 	<p>EV-HEV:</p> <ul style="list-style-type: none"> (i) calculation method of each phase range for pure electric vehicles (PEVs); (ii) Shortened test procedure for PEV range test; (iii) Combined CO₂ (fuel consumption) of each phase for off-vehicle charging hybrid electric vehicles (OVC-HEVs); (iv) Hybrid Electric Vehicle (HEV)/PEV power and maximum speed; (v) combined test approach for OVC-HEVs and PEVs; (vi) fuel cell vehicles; (vii) utility factors; (viii) preconditioning; (ix) predominant mode.
<p>APM:</p> <ul style="list-style-type: none"> (i) measurement method for ammonia, ethanol and aldehydes. 	

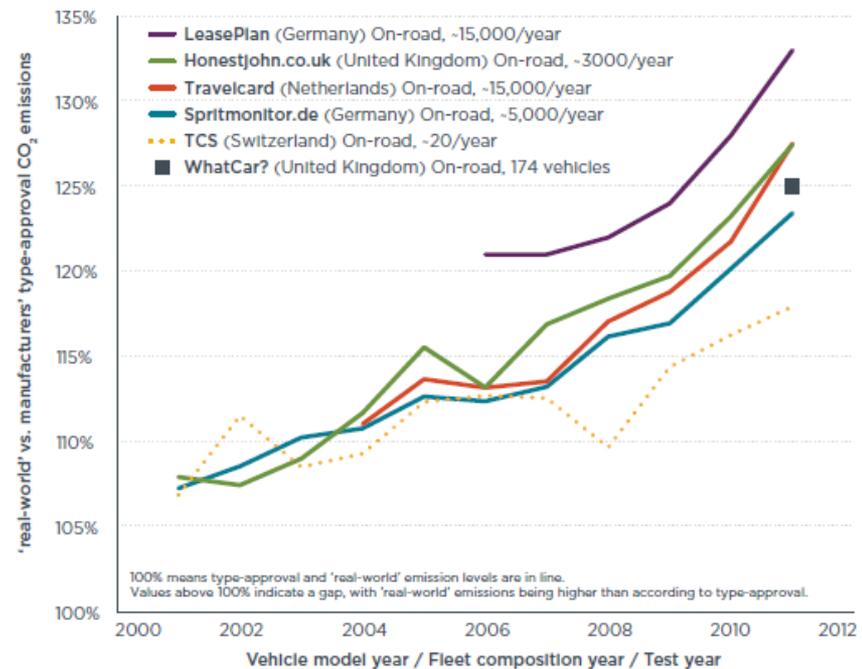
Implementing the WLTP

Application of test requirements for type-approval and extensions

Vehicle category	Vehicles with positive ignition engines including hybrids							Vehicles with compression ignition engines including hybrids		
	Mono fuel				Bi fuel (1)			Flex fuel (1)	Flex fuel	Mono fuel
Reference fuel	Petrol (E5)	LPG	NG/Biomethane	Hydrogen	Petrol (E5) LPG	Petrol (E5) NG/Biomethane	Petrol (E5) Hydrogen	Petrol (E5) Ethanol (E85)	Diesel (B5) Biodiesel	Diesel (B5)
Gaseous pollutants (Type 1 test)	Yes	Yes	Yes		Yes (both fuels)	Yes (both fuels)		Yes (both fuels)		Yes
Particulates (Type 1 test)	Yes (direct injection)	—	—		Yes (direct injection) (petrol)	Yes (direct injection) (petrol)		Yes (direct injection) (both fuels)		Yes
Idle emissions (Type 2 test)	Yes	Yes	Yes		Yes (both fuels)	Yes (both fuels)		Yes (both fuels)		—
Crankcase emissions (Type 3 test)	Yes	Yes	Yes		Yes (petrol)	Yes (petrol)		Yes (petrol)		—
Evaporative emissions (Type 4 test)	Yes	—	—		Yes (petrol)	Yes (petrol)		Yes (petrol)		—
Durability (Type 5 test)	Yes	Yes	Yes		Yes (petrol)	Yes (petrol)		Yes (petrol)		Yes
Low temperature emissions (Type 6 test)	Yes	—	—		Yes (petrol)	Yes (petrol)		Yes (?) (both fuels)		
In-service conformity	Yes	Yes	Yes		Yes (both fuels)	Yes (both fuels)		Yes (both fuels)		Yes
On-board diagnostics	Yes	Yes	Yes		Yes	Yes		Yes		Yes
CO ₂ emissions and fuel consumption	Yes	Yes	Yes		Yes (both fuels)	Yes (both fuels)		Yes (both fuels)		Yes
Smoke opacity	—	—	—		—	—		—		Yes

Implementing the WLTP

- NEDC is the test cycle for type-approval in EU
- There is increasing evidence that NEDC is not representative of real-world emissions
- Part of the reduction in terms of overall CO₂ is likely to be connected to the flexibilities allowed by NEDC
- EC is aiming to introduce the WLTP in the shortest possible time-frame



Source: ICCT White paper 2013

Implementing the WLTP

Table 1

Character	Emissions standard	OBD standard	Vehicle category and class	Engine	Implementation date: new types	Implementation date: new vehicles	Last date of registration
A	Euro 5a	Euro 5	M, N ₁ class I	PI, CI	1.9.2009	1.1.2011	31.12.2012
=====							
W	Euro 6b	Euro 6-1	M, N ₁ class I	PI, CI	1.9.2014	1.9.2015	31.8.2018
X	Euro 6b	Euro 6-1	N ₁ class II	PI, CI	1.9.2015	1.9.2016	31.8.2019
Y	Euro 6b	Euro 6-1	N ₁ class III, N ₂	PI, CI	1.9.2015	1.9.2016	31.8.2019
ZA	Euro 6c	Euro 6-2	M, N ₁ class I	PI, CI	1.9.2017	1.9.2018	
ZB	Euro 6c	Euro 6-2	N ₁ class II	PI, CI	1.9.2018	1.9.2019	
ZC	Euro 6c	Euro 6-2	N ₁ class III, N ₂	PI, CI	1.9.2018	1.9.2019	

Implementing the WLTP

M + N1 class I

Euro 6 – Step 2

Adjustment of CO2
regulations

Sept. 2017 New types
Sept. 2018 New vehicles

Regulations (EC) No 443/2009 & (EU) No 510/2011

Art.13(7 amended):

The Commission shall, by means of an implementing act, determine the correlation parameters necessary in order to reflect any change in the regulatory test procedure for the measurement of specific CO2 emissions referred to in Regulation (EC) No 715/2007 and Regulation (EC) No 692/2008.

The Commission shall be empowered to adopt delegated acts in accordance with to adapt the formulae in Annex I using the methodology adopted pursuant to the first subparagraph while ensuring that... comparable stringency for manufacturers and vehicles...

Implementing the WLTP

N1 class II and III

Euro 6 – Step 2

Adjustment of CO2 regulations

Sept. 2018 New types
Sept. 2019 New vehicles

Regulation (EU) No 510/2011
Art.13(6, amended par. 4):
The Commission shall, by means of an implementing act, determine the correlation parameters necessary in order to reflect any change in the regulatory test procedure for the measurement of specific CO2 emissions referred to in Regulation (EC) No 715/2007 and Regulation (EC) No 692/2008.
The Commission shall be empowered to adopt delegated acts in accordance with to adapt the formulae in Annex I using the methodology adopted pursuant to the first subparagraph while ensuring that... comparable stringency for manufacturers and vehicles...

Implementing the WLTP in EU legislation

Adjustment of CO2 Regulations: from NEDC to WLPT – the Correlation project

- While the introduction of WLTP as Type 1 test for the measurement of gaseous pollutants and particulates is quite straightforward (same emission limits as with NEDC), the replacement of NEDC in the CO2 Regulations is more complex.
- The reason is connected to the mandate given to the Commission to ensure that the CO2 reduction requirements are of “**comparable stringency for manufacturers and vehicles of different utility**” following the change in CO2 tests
- The boundaries for the mandate are due to the fact that CO2 targets can be decided by the EU legislator - not by the Commission... This constraint was necessary due to the way CO2 regulations for LDVs are applied in EU

EU Regulations on CO₂ from LDVs

- In the EU, CO₂ **emission targets for LDVs** are defined by Regulations 443/2009 (PC) and 510/2011 (LCV) (around 10 year lead time needed for target setting to ensure OEM planning certainty)
- Regulations define **overall targets** (fleet-wide) and a **function to relate CO₂ emission targets with the vehicle mass** for 2015 and 2020
- Regulations apply to the **average CO₂ emission** from the annual new fleet of single manufacturers or pools of them
- Compliance against the targets is assessed by a **EU-wide monitoring system** defining on a yearly basis the number of registrations per each vehicle type/variant and the corresponding type-approval CO₂ emissions (as of Regulation 715/2007) and mass

EU Regulations on CO₂ from LDVs

- If the annual target is exceeded a manufacturer will have to pay an excess emission premium of about 95€ per each gram of CO₂ exceeding the target and per each vehicle sold by the same manufacturer in the same year
- OEMs have already programmed how the 2017-2020 NEDC-based targets should be met. The change in test procedure could have serious implications for target compliance;
- *A correlation of the NEDC-based emissions and the new WLTP-based emissions is required*
- In May 2013 a Technical Working Group composed of MSs, OEMs, technical experts and stakeholders has been set-up to support the EC for the NEDC/WLTP correlation
- The correlation study must deliver results before the end of 2014 to have sufficient time for implementation in CO₂ regulation

NEDC/WLTP Correlation: overall approach

- **technical correlation exercise**

This contains two sub-steps:

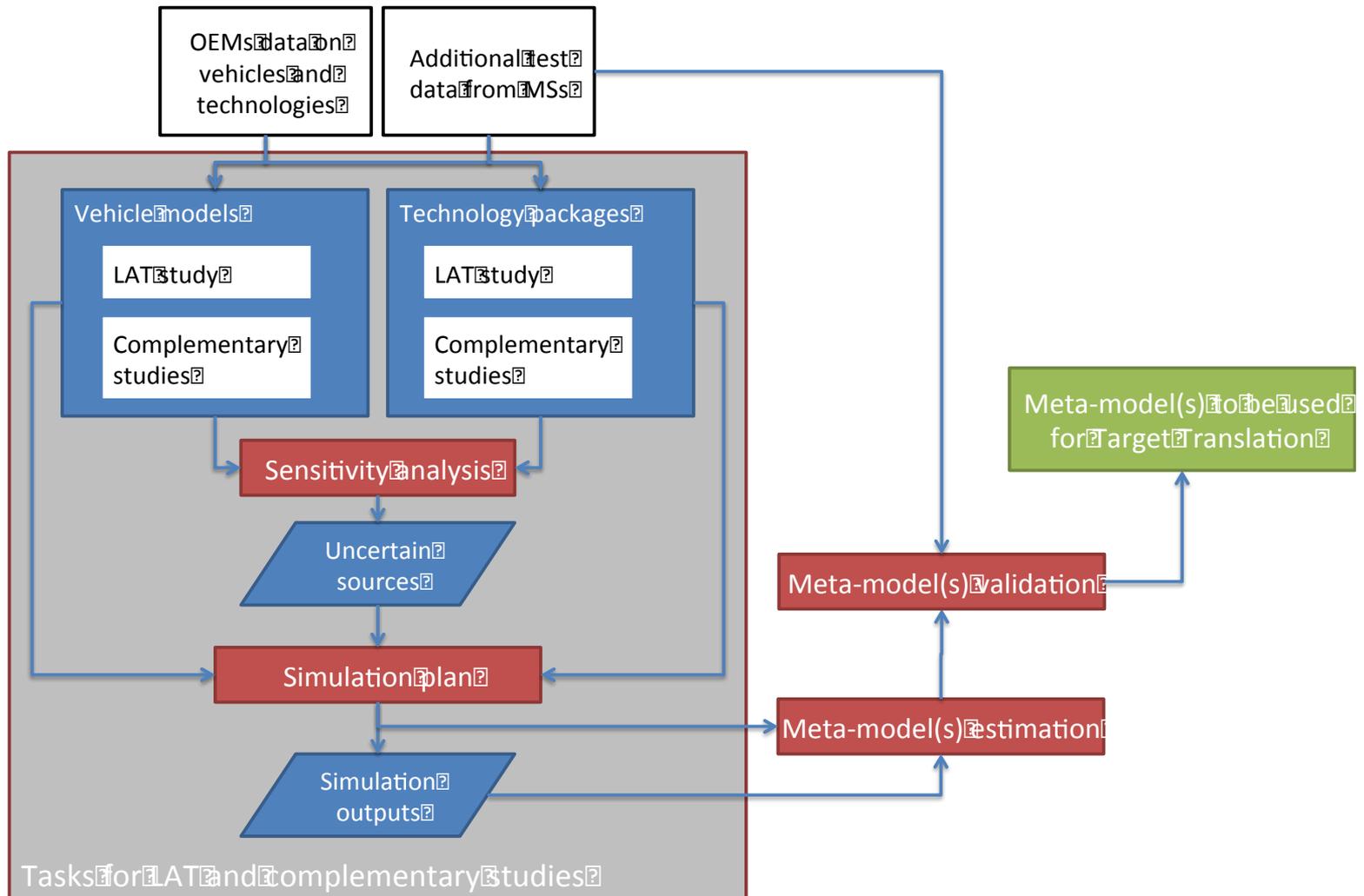
- Determining **CO₂ emissions** evaluated on the **NEDC** and on the **WLTP** for a **range of vehicle configurations and technology packages**;
 - Determination of a **generalised correlation function** between CO₂ on the NEDC and the WLTP;
- **correlation of CO₂ emissions measured on the NEDC and emissions measured on the WLTP**
 - on the basis of agreed criteria ensuring comparable stringency
 - using insights from the technical correlation exercise

The technical correlation exercise

- Two possible approaches: testing vs. modeling/simulations
- A **mixed approach** is adopted:
 - mostly based on **modeling** combined with results from vehicle testing
 - **Pros:**
 - cost effective
 - combined pros of both approaches while avoiding many of the cons
 - improves acceptance and robustness of modeling results
 - allows evaluation of aspects of the tests that cannot be adequately simulated
 - **Cons:**
 - costs somewhat higher than for approach based on modeling alone

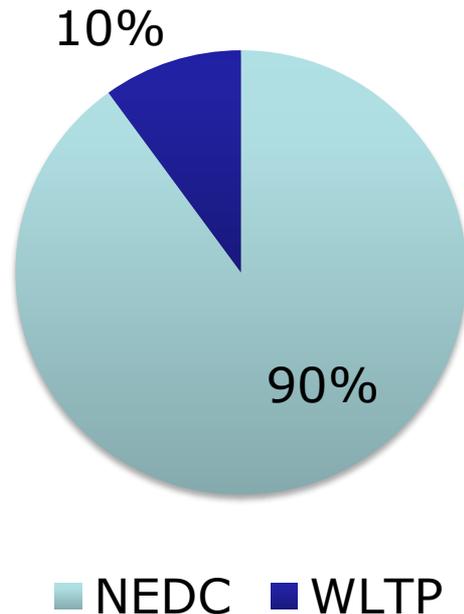
Steps in the technical correlation exercise

- Definition of a range of **vehicle configurations**:
 - Starting point is the most recent vehicle registration database available for Europe
 - The car market is divided into different **technology-based segments**
 - For each segment a **representative vehicle** model is selected
- The **simulation model** for each vehicle is developed
- Using the model, **NEDC- and WLTP-based CO2 emissions are evaluated** on different combinations of key vehicle parameters (mass, power, transmission, etc.) and technology options
- Simulation results are used to **estimate the general CO2 correlation function**



2017 – Average target: 130g/km

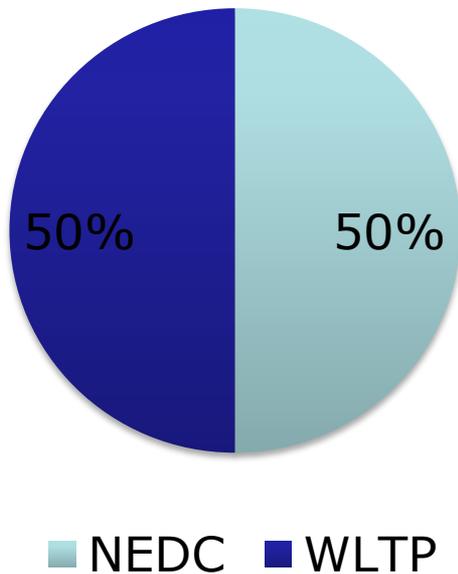
Type Approval



- Only new types of vehicles are Type-approved in WLTP in the period Sep-Dec
- Average CO₂ emissions around 110g/km
- *No effect on compliance of possible inaccuracy of the correlation*

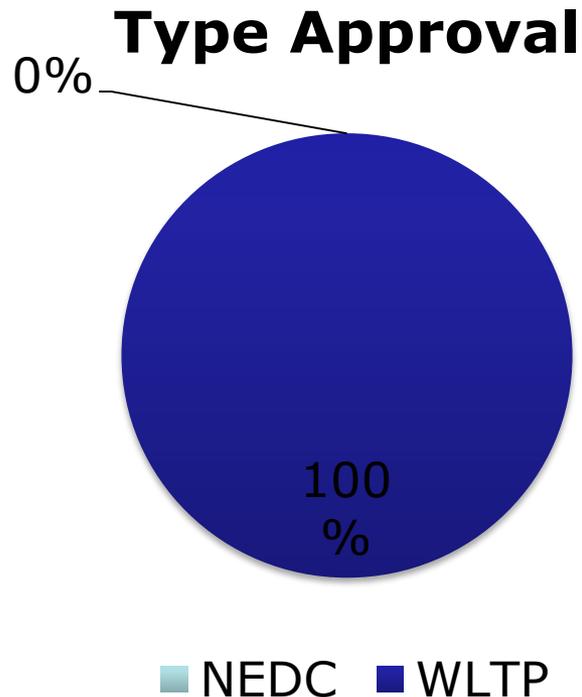
2018 – Average target: 130g/km

Type Approval



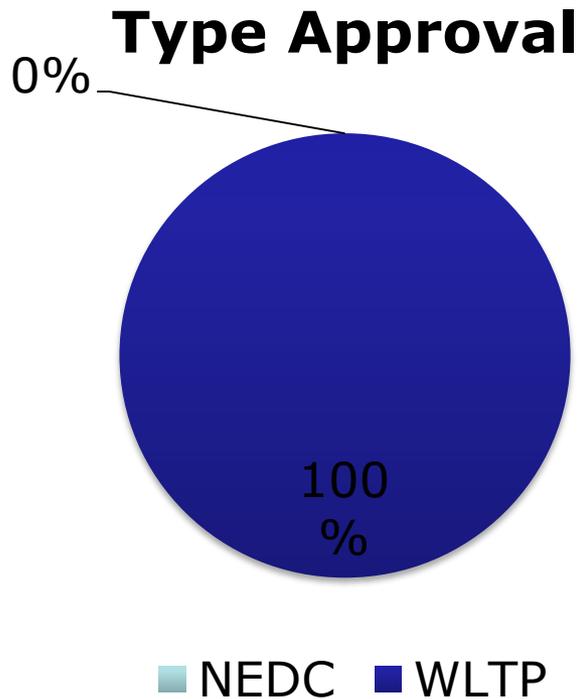
- Only new types of vehicles are Type-approved in WLTP in the period Jan-Aug
- All types Sep-Dec
- Average CO₂ emissions around 105g/km
- *No effect on compliance of possible inaccuracy of the correlation*

2019 – Average target: 130g/km



- All models WLTP TA
- Average CO₂ emissions around 100g/km
- *Only an average bias in the correlation of around 30g/km can affect the compliance to target*

2020 – phase in of average target: 95g/km (95% of the fleet)



- All models WLTP TA
- Average CO₂ emissions around 98g/km (95g in 2021)
- *Compliance to target potentially strongly influenced by accuracy in the correlation if WLTP values are translated back to NEDC*

Correlation of CO₂ emissions and targets

EC objective: to phase out NEDC as soon as possible whilst taking into account the need to ensure that CO₂ reduction requirements are of comparable stringency:

- **1 Sept 2017-2019: NEDC based CO₂ targets are maintained; WLTP measurements will be correlated back into NEDC values**
- **2020-2021: Adopt the same approach or determine WLTP based targets?**
- Choice to be discussed in the Technical Working Group taking into account, in particular
 - Accuracy of the correlation method
 - Practical implementation issues
- Decision to be taken later in 2014 based on available data

Conclusions and open points

- By end of 2014 the **WLTP** (Type 1 test) will be **completed** and the GTR will be ready.
- The *EC aims to introduce WLTP in the shortest possible time-frame* to address the problems of representativeness of NEDC
- To introduce the new test-procedure the EC is committed to ensure that CO₂ reduction requirements are of comparable stringency following the change in test procedure
- The Commission has a mandate to define a *correlation methodology* and where appropriate adjust the CO₂ emission target formulae to reflect the new test procedure
- Due to the low accuracy implications, at least for a transition period (2017-2019) the **target will be still based on NEDC and the WLTP measures translated to equivalent NEDC values.**

Relevant EU Legislation

Euro 5/6 Light Duty Vehicles

- Directive 2007/46/EC
- Regulation_EC_715_2007
- Commission_Regulation_692_2008
- Reg_459_2012_PN
- Commission_Regulation_136_2014

CO2 Passenger Cars and Light Commercial Vehicles

- Regulation_EC_443_2009
- Regulation_(EU)_510_2011