



02/06/2021

Introduction

SORT protocol

- Electric range of urban buses in public transport



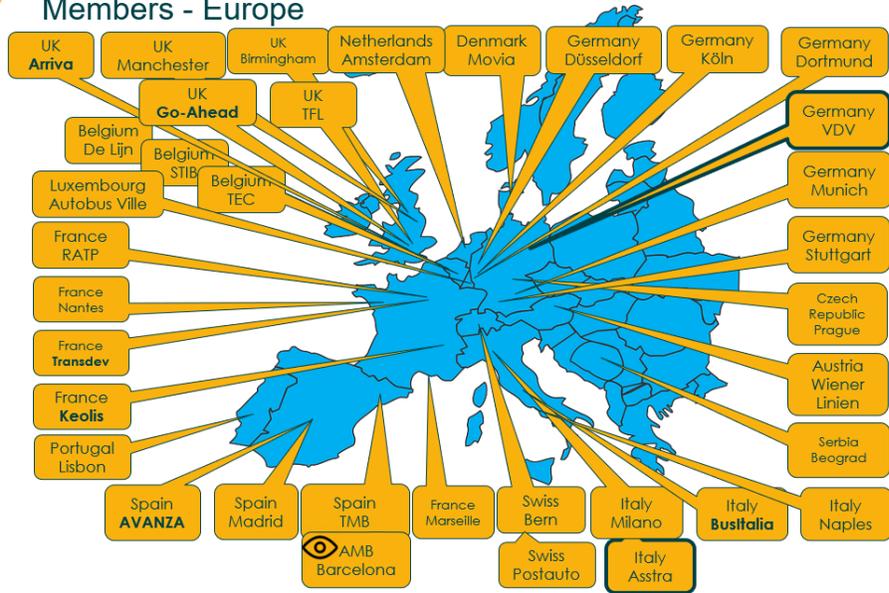
GRPE workshop on low- and zero-emissions heavy duty vehicles : Regulatory gaps and expected legislators' needs
2 June 2021 : 12.00 – 15.45



Overview of SORT use, in Europe and outside



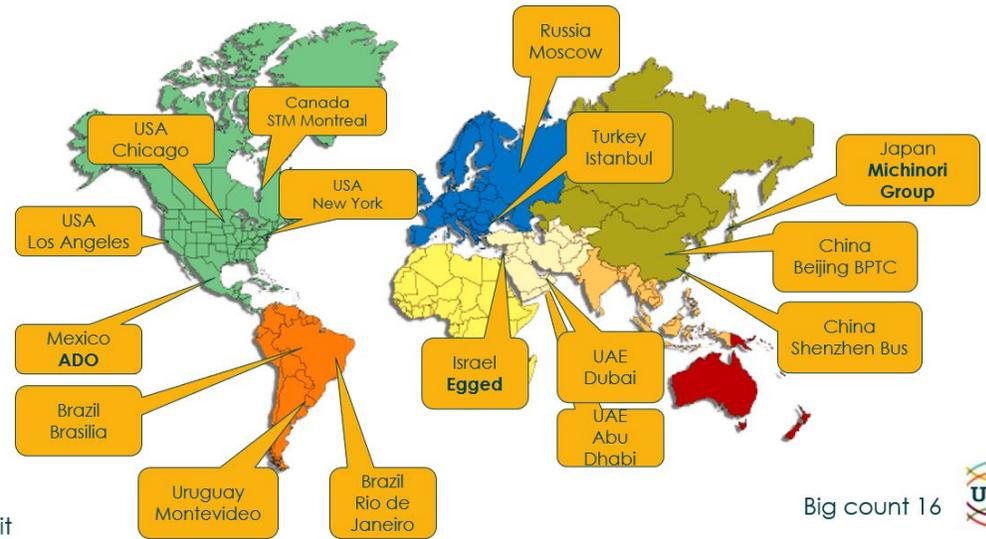
UITP Bus Committee Members - Europe



Big count 38



UITP Bus Committee Members – Outside Europe



UITP Bus Unit

Big count 16





History

- Since 2004, UITP has been editing a standardized protocol, aiming at comparing the energy consumption of buses.
- First dedicated to 12 meter diesel buses, it has been gradually extended to all bus sizes (from midi-buses to articulated or double-decker vehicles), and to all energy sources (liquid or gaseous fuels, electricity) in any combination.
- This methodology results from a collaboration between operators, testing track facilities, bus and gearbox manufacturers.
- Called “SORT” (for “Standardized On Road Testcycle”), this protocol is now well renown in the public transport sector.



Objectives

- **SORT methodology allows bus operators to compare energy consumption of buses in a standardized way, without needing any specific customer testing.**
- **3 different driving cycles have been defined, each corresponding to a typical commercial speed (12, 18 and 25 km/h).**
- **For any specific operating condition, a realistic consumption can be predicted by an appropriate combination of 1 to 3 SORT consumptions.**
- **Note: energy consumption from auxiliaries not strictly necessary to bus propulsion, like heating or air-conditioning, can not be predicted by SORT tests, as these devices are switched off during the tests; these consumptions will be addressed in a standardized way in the next revision of « Tender Structure Document ».**



Concept

Figure 14: Comparison of SORT cycles with operation data

Comparison of stops per kilometer vs. standstill time:

- Data read out from DIWA ECU
- SORT cycles

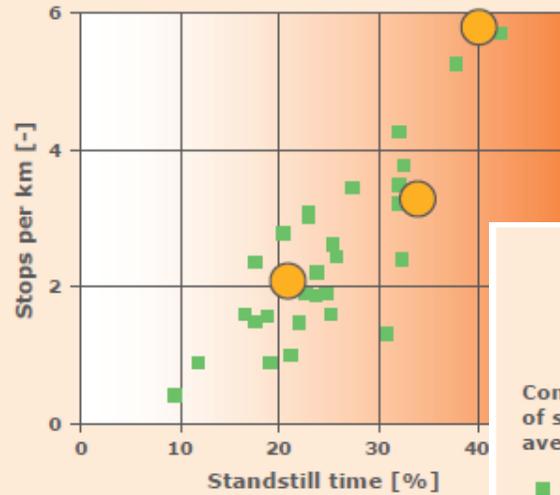


Figure 15: Comparison of SORT cycles with operation data

Comparison of time of standstill vs. average speed:

- Operation data read out from DIWA ECU
- SORT cycles

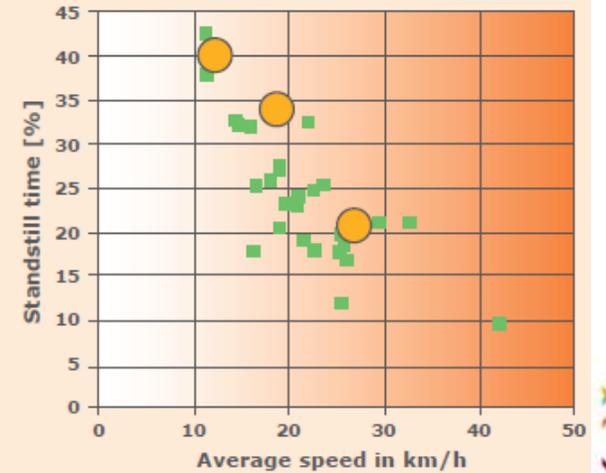
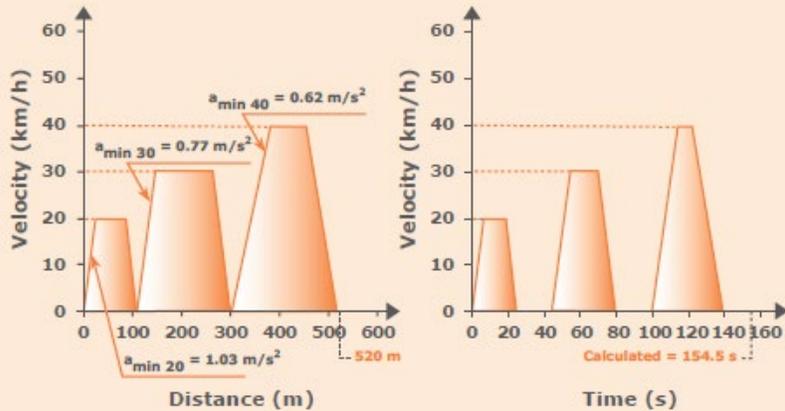


Figure 9: SORT 1: Heavy Urban

Acceleration $a_{\min} = f(v)$
Deceleration $b = 0.8 \text{ m/s}^2$

Average speed $v_m = 12.1 \text{ km/h}$





SORT protocol applicability

2017

Full electric & plug-in hybrids



2015



Gaseous fuels

2015

Double-deck buses



2014



Non plug-in hybrids

2009

9 to 18 m single deck buses



2004



12 m single deck diesel buses



This file contains three types of sheets which are identified by the color of the tab:

Color of the tab :	Content of the sheet :	Encoding allowed ?
Green	Entering of the values of the test and automatic calculation of the results.	Only white cells
Yellow	Common informations to all the tests	No
Orange	Intermediate calculations which do not need any action from the user	No

Rem : A cell with a red background indicates that something is abnormal in the values / e.g. wind speed is higher than the SORT specifications, weight of the loaded bus is lower than the calculated weight, measured consumption is higher than the tolerance (5%).

According if one measures the consumptions by measuring the weight or by volume, one has to use respectively the sheet "Massique consumption measurements" (tab n°5) or "Volumique consumption measurements (tab n°6)".

The pop-up message "Number of measurements insufficient" disappears when 3 measurements are falling within the maximum foreseen interval by SORT (2 %).

USER'S NOTICE TEST EXTENSION CONDITION REMOVE DETAIL Measurement performance Multiple loop measurement

Annex: excel spreadsheet





How to use SORT protocol as an operator?

- The main parameter is the average speed of the line (called « commercial speed »)
- This speed allows to chose weighing factors between SORT 1 (12 km/h), SORT 2 (18 km/h) and SORT 3 (25 km/h)
- **Notice that the weighing factors:**
 - Do not apply to the speeds, but to the consumptions!
 - Do not have to sum-up to 100%!
 - For example:
 - For a commercial speed of 25 km/h, use only SORT 3 consumption
 - For a commercial speed of 16 km/h, use a combination of SORT 1 & SORT 2 (for example: 0.7/0.3)
 - You may need to adjust these factors by iteration, based on existing data



How to use SORT protocol as a bus manufacturer?

For each SORT cycle needed by the operator, let the energy consumption be measured, either in-house, or by an independant test track facility

Rem.: in case of in-house measurment, the operator is allowed to ask for a counter-test prior to, or after, bus delivery

These data will be valid for answering each tender referring to SORT cycles.



How to use SORT protocol as a test track facility?

For each SORT cycle needed by the manufacturer, measure the energy consumption, in accordance to applicable protocol.

Rem.: always check UITP website for the latest version.



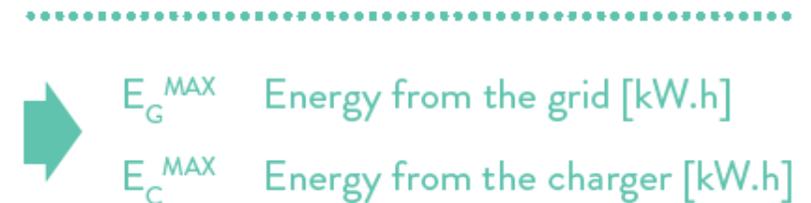
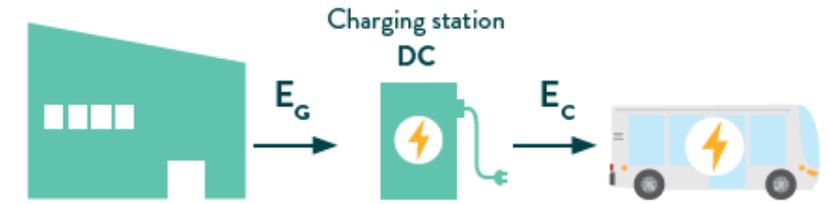
E-SORT main specificities

1. The usable energy of Rechargeable Energy Storing System (“RESS”) has to be measured, during a simple static test.
2. The energy consumption has to be measured for each required SORT cycle, following classical cycles.

USABLE ENERGY CONTENT: 2ND STEP: BATTERY CHARGE

Measure the electricity:

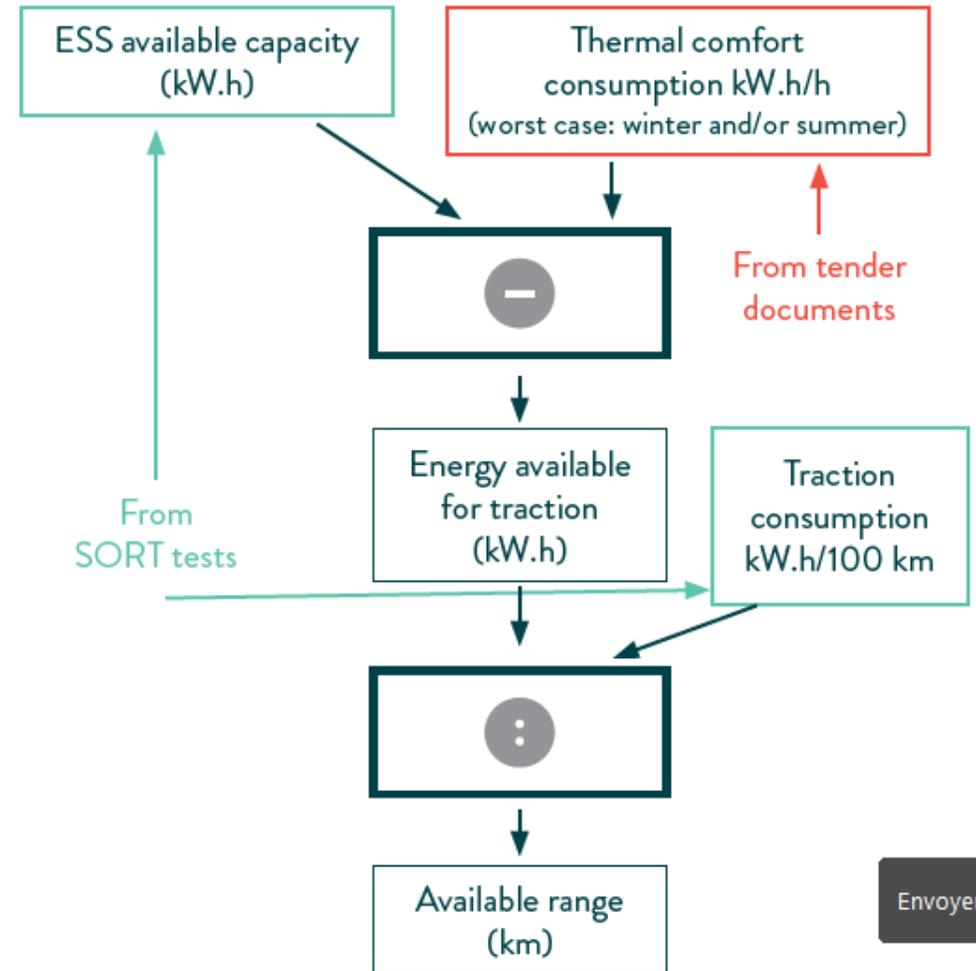
- upstream of the charger (E_G)
- downstream of the charger (E_C)





E-SORT main specificities

1. The maximal achievable zero emission range has to be calculated, based on the results of these tests and on auxiliaries' consumption, estimated in accordance to tender documents

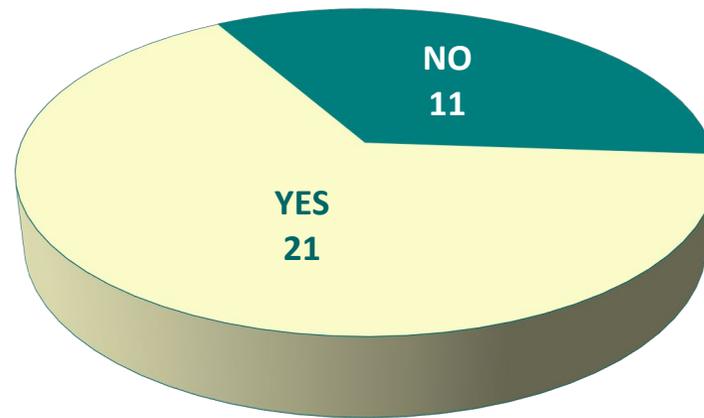




SORT Use (2017 survey)

Q1 : Have you ever asked for « SORT » values in your tenders ?

32 ANSWERS



■ YES
66 %

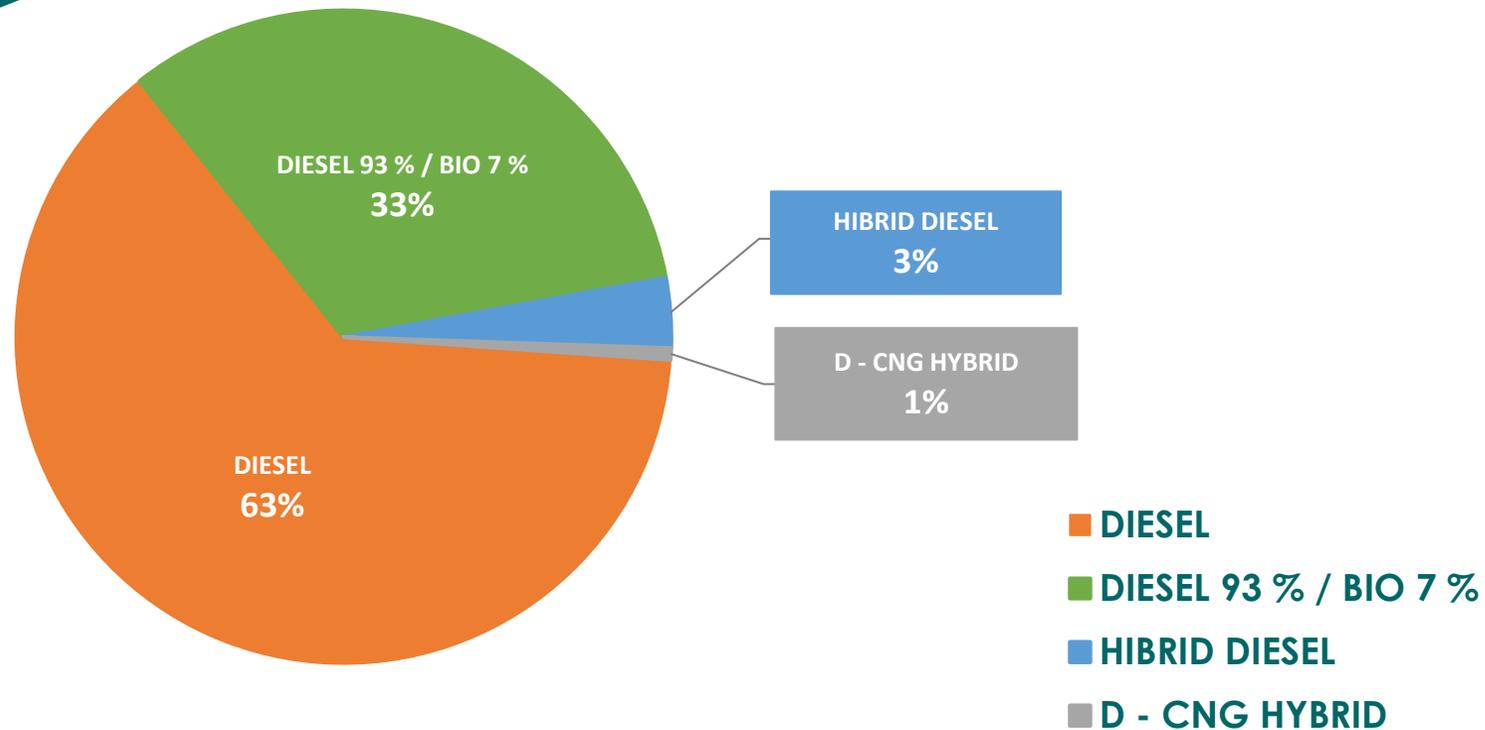
■ NO
34 %



RESULTS (2017 survey)

FUEL PROPORTIONS

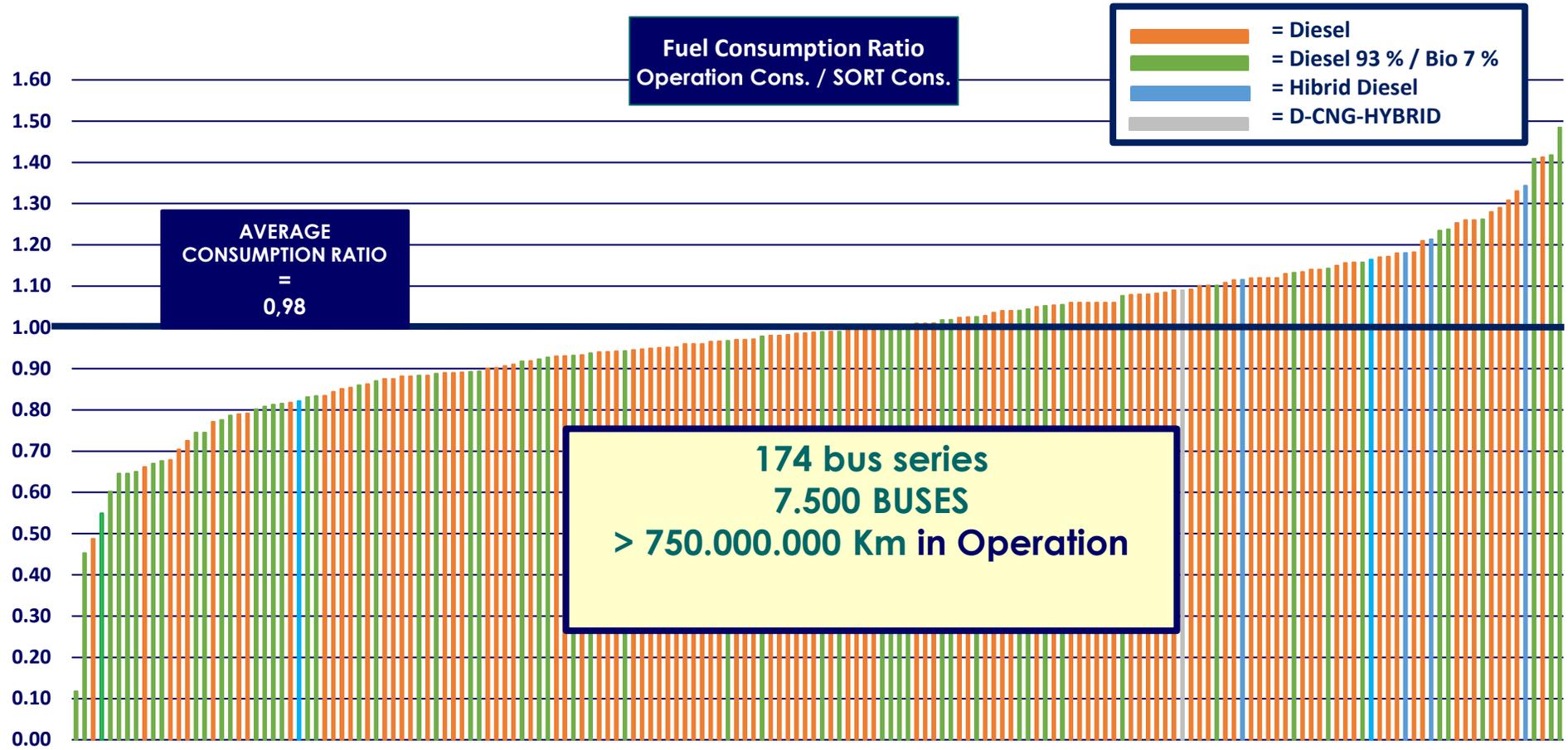
174 values





Results (2017 survey)

Q2 : Do you have comparative results between SORT values & real operation values ?





SORT roadmap: *Coordination with EU and ACEA on CO₂ regulation*



- **Simulation** of fuel consumption with a standardized VECTO tool
- **Regulated** process, standardized component measurements, administrative fines, ... controlled by TS and TAA
- **One procedure** for ICE, HEV, BEV. Tender for FuelCell integration available.
- Values determined for **each individual vehicle** (delivered and **registered**)



SORT



- **Measurement** of fuel consumption based on standardized drivecycle and protocol
- UITP-described process, **excluding HVAC (ongoing process)**.
- Execution under **control** of OEM and TS; affordable **counter tests manageable** by the customer
- **Available** and **in use** for all technologies (diesel, gas, hybrids, EV...).
- Values determined for **types of vehicle** (chosen by OEM)





SORT roadmap: Coordination with EU and ACEA on CO₂ regulation



SORT



Requirements from the PTO/PTA's to rely on VECTO results instead of SORT data for purchasing:

- **PROVIDE RELIABLE DATA** → knowledge sharing on VECTO assumptions and simulation models
- **ENSURE DATA ACCURACY BEFORE, DURING AND AFTER THE "VECTO" DEVELOPMENT PROCESS**
 - keep the on-road verification as part of the official VECTO procedure
 - monitor the data at EU level, and provide a warning mechanism to allow users to report if observed values out of specifications





SORT roadmap: *Coordination with EU and ACEA on CO₂ regulation*



SORT



Requirements from the PTO/PTA's to rely on VECTO results instead of SORT data for purchasing:

- PROVIDE RELEVANT DATA IN THE CUSTOMER SHEET
→ one value for **each energy source** (fuel, electricity...) and for **each driving cycle**, to allow each end-user to convert them in relevant units (energy budget, GHG impact...), based on its **own context** (electricity mix, energy prices...).
- POSSIBILITY TO RUN VECTO BASED ON A SPECIFIC REAL-LIFE DRIVING CYCLE
→ this use of VECTO tool should be as easy as possible, to refine the energy use estimation on each specific network
- INCLUDE ALTERNATIVE TECHNOLOGIES





SORT roadmap: *Coordination with EU and ACEA on CO₂ regulation*

SORT → VECTO convergence plan:



Step 1: “White Book” under review by Bus Committee experts (Q2/2021)
Position paper under revision between UITP & ACEA (Q2/2021)

Step 2: Simulations to be run using VECTO simulation AND SORT driving cycle for comparison with already available SORT measurements (Q3/2021 → Q4/2022)

Step 3: progressive switch from SORT measurement to VECTO data?





SORT roadmap: next steps

Thermal comfort for buses: ongoing process:

1. Standardized way to measure passengers' satisfaction in terms of thermal comfort:

- define standardised procedure to monitor satisfaction levels of passenger comfort whilst minimising the energy use and wear of the HVAC (Heating-Ventilation-Air Conditioning) system
- Particularly relevant on zero emission busses to maximize range, but also important to help reducing the carbon footprint of all modes of buses.
- Standardized way to describe climatic requirements in each tender document

2. Standardized way to measure energy used by HVAC system



Active contributors

Industry:

ADL, BAE, EBUSCO, EVOBUS, GREEN PROPULSION, HESS, HISPACOLD, MAN, SAFRA, SCANIA, SOLARIS, VAN HOOL, VDL, VOITH, VOLVO, YUTONG, ZF...

Operators:

Barcelona, London, Madrid, Torino, RATP, TEC, TRANSDEV, VDV, KEOLIS, ARRIVA, De Lijn, Beograd...

Proving grounds:

MILLBROOK, TNO, VTT, TÜV, IDIADA.



References

Arno KERKHOF (UITP):

arno.kerkhof@uitp.org

Christophe MARTIN (TEC):

christophe.martin@letec.be

<https://www.uitp.org/publications/uitp-sort-e-sort-brochures/>

Pour Master brochure **SORT 2014**

Main entry : <https://mylibrary.uitp.org/Record.htm?idlist=132&record=19267648124910858209>

Version Chinoise: <https://mylibrary.uitp.org/PermaLinkRecord.htm?archive=181681390986>

Pour brochure **E-sort 2017**

Main entry : <https://mylibrary.uitp.org/Record.htm?record=19310909124911381819>

Version Chinoise: <https://mylibrary.uitp.org/PermaLinkRecord.htm?archive=181680290986>

