Development of integrated cost curves for the European light-duty vehicle market

ICCT International Workshop on greenhouse gas reduction potential and costs of light-duty vehicle technologies

John Germany, Peter Mock

February 1, 2012

Brussels

icct
THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

Outlook & next steps

Status / planning of EU technology analyses

Ricardo potential analysis

- ✓ Vehicle classes: B, D, CUV, large N1
- ✓ New vehicle class: C segment
- ✓ New vehicle class: small N1 vehicle
- ✓ Gasoline direct injection and downsizing (stoichiometric and lean-burn)
- ✓ EGR direct injection turbo engine
- ✓ Atkinson Cycle engine
- ✓ P2 and powersplit hybrid
- ✓ Advanced diesel technology (updated diesel map and recalculations)
- ✓ Advanced transmission technologies
- ✓ Manual transmission sensitivity
- ✓ NEDC and JC08 (Japan) results

FEV cost analysis (phase 1)

- ✓ Gasoline direct injection and downsizing
- ✓ Automatic and dual-clutch transmissions
- ✓ Start-stop hybrid (belt alternator type)
- ✓ P2 and powersplit hybrid
- ✓ Electrical air conditioning compressor

FEV cost analysis (phase 2)

- ○ Advanced diesel technology
- ○ Manual and dual-clutch transmissions
- ○ EGR direct injection turbo engine
- ○ Advanced start-stop technology
- ○ Lightweighting measures

US EPA results transferred to EU conditions
New work specifically for ICCT

icct THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

Outlook & next steps
Developing cost curves for EU LDVs

- Ricardo potential analysis
- FEV cost analysis (phase 1)
- FEV cost analysis (phase 2)
- Additional sources

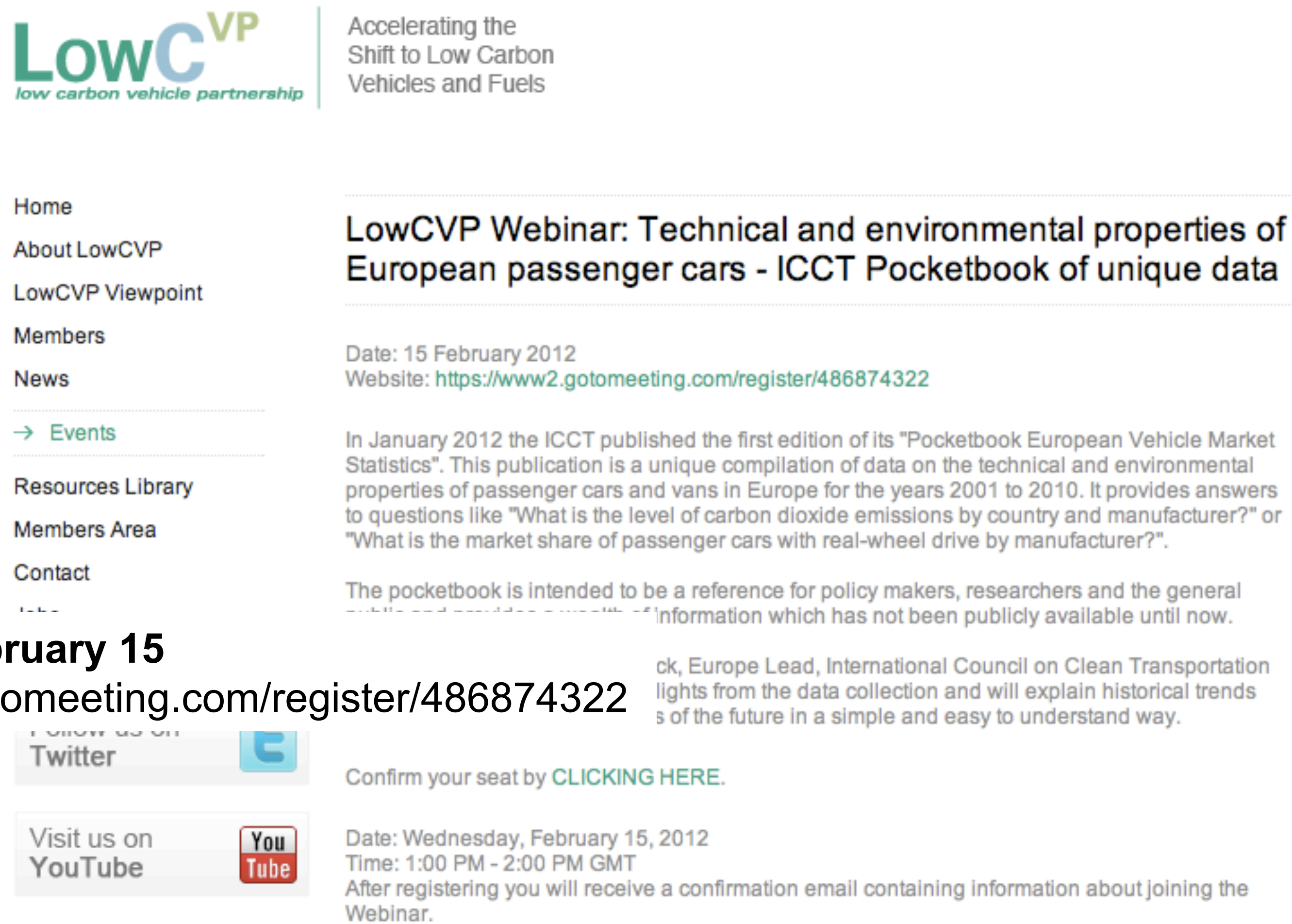
→ **development of individual <u>cost curves</u> for each vehicle segment**

ICCT – THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

Outlook & next steps
Timing

- **February 1:**
  Workshop to show preliminary results from Ricardo and FEV studies and to have a discussion with experts / interested stakeholders
- **February:**
  Release of final reports on Ricardo simulation work and FEV phase 1 analysis
- **March / April:**
  Workshop to show final results from FEV phase 2 analysis and ICCT cost curves for EU light-duty vehicles in 2020/25
- **May / June:**
  Publication of ICCT report summarizing the results

Supporting work
"Pocketbook" EU vehicle market statistics



Webinar on February 15
https://www2.gotomeeting.com/register/486874322

Supporting work

Working papers on various issues

Working paper
2011-5

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

Development of a Worldwide Harmonized Light Vehicles Test Procedure (WLTP)

ICCT contribution No. 3 (focus on inertia classes)

Author: Peter Mock

Date: September 2011

Paper number: 2011-5, WLTP-LabProcICE-091

Keywords: WLTP, inertia class, step-less

Introduction

For historic reasons we make use of inertia classes and upper limits for inertia mass during the vehicle testing procedures today. Historically, the weight of a vehicle was represented by hanging rotating inertia mass on a dynamometer. This approach required the use of discrete inertia classes and an upper limit for inertia mass. Modern electronic dynamometers no longer impose these limitations. As a result it is now possible to revise existing test procedures and provide more accurate emission and fuel consumption values to consumers.

This document builds on explanations that were given in the documents WLTP-DTP-LabProcICE-054, 067, 077 and WLTP-DTP-06-11.[1] It presents new analysis on the implications of the current inertia class based system and outlines two alternative approaches for discussion within the WLTP-DTP working group.

Shortfalls of the current inertia class approach

In 2011 for the first time detailed data on EU new passenger car registrations at the vehicle version level was published in the context of the European Commission CO_2 monitoring system.[2] This data also contains the reference mass for each entry. This allows a thorough analysis of the distribution of new vehicle registrations by mass for the European new passenger vehicle fleet.

As seen in Figure 1, there is a tendency for a higher number of vehicle registrations just below an inertia class step compared to the number of registrations just above an inertia class step or in between inertia class steps. When dividing the mass difference between two inertia class steps into ten equally large bins and aggregating the number of vehicle registrations along these bins, this tendency becomes even more striking (Figure 2).

When aggregating overall inertia classes the effect can be quantified more precisely. As Figure 3 demonstrates, about 28% of all vehicle registrations are associated with a reference mass that is just below an inertia class step (0-10% below a step). In contrast, less than 5% of all registrations are associated with a mass just above an inertia class step. The likelihood of a vehicle having a mass slightly below an inertia class step is more than five times higher than having a mass slightly above an inertia class step. These findings strongly suggest that manufacturers optimize the weight of their vehicles with respect to the discrete inertia class steps.[3] If no optimizing were taking place, a rectangular type distribution would be expected.

The implication of this is that while there is a strong incentive for manufacturers to reduce the weight of their vehicles marginally to make sure that they "jump" into the next lower inertia class and gain an advantage in terms of CO_2 emissions / fuel consumption testing, these lower test

3 Similar findings have been reported for the US fleet where this has led to a split of inertia classes to make them smaller in size and thereby reduce

Working paper
2011-8

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

Estimated Cost of Gasoline Particulate Filters

Authors: Ray J Minjares and Francisco Posada Sanchez

Date: September 2011

Paper number: 2011-8

Keywords: particulate filter, cost savings, catalyst

The gasoline particulate filter (GPF) is a device that can be installed on the tailpipe of a gasoline vehicle to capture and reduce emissions of particulate matter, a common pollutant. The European Commission is considering proposals for early adoption of gasoline particle number limit values by late 2011 or early 2012 (Steininger, 2011a). Likewise in California in tandem with the US EPA, regulators are considering actions to lower the particle mass limit based on the cost and availability of control strategies for particulate matter emissions from gasoline direct injection engines (GDI). The cost of a GPF may therefore affect the stringency of new tailpipe standards.

Some GPF cost estimates have been given publicly. The European Commission's Klaus Steininger has suggested a GPF cost between $57 and $184 (Steininger, 2011b). The Manufacturers of Emissions Controls Association (MECA) currently estimates a cost between $50 and $100 (Kubsh, 2011). The European Joint Research Center (JRC) is now undertaking a cost benefit analysis intended to evaluate GPF costs.

Based on an assessment of production costs for two GPF designs, we estimate for a 2.0L gasoline engine a cost of $106 for a stand-alone GPF and between $114 and $154 for a four-way catalyst, presented here as a three-way catalyst (TWC) with PM trapping capabilities. The true cost will depend on the choice of the system being installed, the production volume, and changes in the

Approach 1: Stand-Alone GPF

The GPF can be installed as a separate addition to the three-way catalyst. We can make a preliminary cost estimate based on past experience with the diesel particulate filter. Both devices operate on a similar principle. All things being equal, an estimate can be based on the change in volume of the filter alone. However, we make one important distinction: we assume a regeneration system is not necessary since we expect gasoline exhaust to achieve sufficiently high average temperatures to continuously regenerate. Therefore, we do not include a regeneration system in this cost estimate.

A study of particle filters installed on GDI engines considered three filter sizes (Mikulic, Koelman, Majkowski, & Vosejpka, 2010). Based on an engine displacement of 2.0 L, the catalyst to engine ratio or Swept Volume Ratio (SVR) for each of these was 0.41, 0.55, and 0.7 for a 3", 4" and 5" length filter, respectively. This gives an average SVR of 0.55. For comparison, the average SVR of a conventional diesel particulate filter is 2.0.

Other assumptions for estimating GPF cost are taken from the ICCT diesel particulate filter cost model. These include assumptions about the cost of substrate ($30 per catalyst volume in liters), washcoat ($10 per CV), and filter can housing ($5 per CV). Accessories ($5) and a differential pressure sensor ($28) are a fixed cost irrespective of CV.

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

Supporting work

ICCT staff blog

http://www.theicct.org/blogs/Staff

icct
THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

Contact details

Peter Mock
peter@theicct.org
+32 486 182 847

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION