1. Purpose

Indication
The International Motor Show in Hannover, Germany – IAA Nutzfahrzeuge – is considered as one of the major exhibitions in the commercial vehicle industry and a central meeting point for European automotive manufacturers as well as their suppliers and other affiliated firms and industries to demonstrate their latest achievements in producing innovative products and advanced technologies as well as exchanging information and updating status with regards to the position of other companies and their products/technologies in the mobility, logistics and transport solutions related to commercial vehicles.

Importance
Every year, the IAA show brings major European actors from the commercial vehicles industry, including public and private agents, politicians, industry representatives, and many others under the same roof to meet and exchange information and ideas. With a majority of participants and visitors from Europe (~75%), the IAA show is considered as the central spot for companies, public and private institutions, policy makers, as well as professionals and practitioners in the European commercial vehicle industry. The exhibition hosts around 1500-2000 companies from more than 40 countries as well as journalists, academics, governmental bodies, public and regulatory agencies, professionals and consultants to the automotive industry.

Empirical value
With such characteristics as a central European venue in the commercial vehicles sector, the IAA show is considered as an exceptional occasion to access first hand data on technological progress in this industry and to meet representatives from companies as
well as talking to some of their key personnel from technology development or R&D segments who are responsible for managing the development and advancement of cutting-edge technologies in this field. It can be also considered as a unique opportunity that many competitors can be met and approached at the same time, so that there is a big advantage regarding empirical data triangulation and making comparisons among competitors simultaneously in this occasion. Moreover, during such large events there is always an easy access to a pull of secondary data such as industry journals, business reports, and company’s information and marketing materials which are of a great use for collecting empirical data for an industry level analysis.

**IAA issues political message**

Opening: Around 700 high-ranking representatives from the world of politics and industry came to the start of the IAA. They heard clear statements from politicians about tolls - and clear messages from the industry to politicians.

![Image of Transport Minister Mr. Ramsauer and VDA President Matthias Wissmann](www.iaa.de/fileadmin/user_upload/2012/deutsch/downloads/presse)

Wissmann also put bases into perspective: “They are the CO₂ champions of tourist traffic”. These vehicles must be environmentally friendly and socially acceptable because they allow people to take trips at affordable prices.

Innovations in terms of performance and efficiency are also important. Euro 6 is a key factor for success. “Euro 5 trucks are very good, but Euro 6 trucks and vans are even better. But, only a separate toll class will guarantee success”, he said, looking at the politicians. After all, commercial vehicles drive the future and our roads are the path to this future. “Our well-being is thus based on efficient mobility”, said the VDA President. “So, we are very happy, Mr. Ramsauer, that you intend to make this possible.”

Mr Ramsauer skillfully accepted the task passed on to him by his predecessor. “I am not yet able to give you exact figures, but the toll class for Euro 6 will be introduced on 1st October 2013”, said Ramsauer. “We must wait for the infrastructure cost report to find out the exact prices.” The parliament must then give the final go-ahead.

**Fig. 1: The IAA Impact**


www.iaa.de/fileadmin/user_upload/2012/deutsch/downloads/presse

**Method for data collection**

The data collection method was designed in a way to serve the purpose and the nature of our ongoing research on technological innovation in the heavy vehicle industry. First, our purpose was to collect data on an industry level and our genuine interest was to obtain a broad overview of the industry and in particular regarding environmental innovation (i.e. technological advancements to meet stringent requirements for emissions control and environmental regulations). Second, the fact that collecting empirical data on technological advancement of an industry as such; characterized with vast organizational arrangements and a wide range of actors, disciplines, processes, and large investments involved in conducting research, development, coordinating innovative activities, outsourcing, purchasing, integrating, testing, prototyping, producing and finally demonstrating advanced technologies and products need to be acknowledged in order to be able to design an appropriate research method accordingly. That is, the nature of the
subject of the study determines the most suited ways of data collection. In our case, obviously, going through all those processes for technology advancement and innovative works inside the companies was nor possible (with respect to the time), neither was it permissible (with regards to confidentiality and competition among the firms). Nevertheless, there are studies which provide an inside perspective to the development of new technologies within the firms, but the focus here was on a broader level (the industry) and on acquiring data on a macro perspective rather than firms’ performance per se.

The data collection was carried out through direct observation of companies’ products and their demonstrated technologies and accomplishments, which often was occurred in parallel with reviewing of their catalogues, brochures, and marketing materials provided at the show as well as information delivered through digital media and communicative interfaces (e.g. interactive displays, graphic and animated demonstrations, computer tablets, simulators, etc.). For the sake of efficiency with respect to the limited time-span for empirical data collection (2 days), as well as effectivity with regards to choosing the most relevant samples among the wide range of companies being present at the show, there was a need to find an effective and efficient way to collect data. First, among the list of companies, the European heavy trucks and bus manufacturers were considered beforehand (i.e. as named earlier). Second, by studying the maps, we planned our visit in a way that we could be able to most efficiently cover the targeted companies with regards to their physical location and geographical proximity at the show. Such advance planning was effective in a way that by the end of the second day, we had not only visited all targeted companies, but we also had enough time to review and reflect on our data before we left the show. Following the obtaining of material and information provided by the companies, we sought for more insightful information by asking for individual conversations with representatives from the companies. We sought for managers with comprehensive knowledge on the development of powertrain technologies and inclusive understanding of emissions control regulations, and in particular the Euro standards (i.e. Euro VI) and its relation with the development of new technologies to meet those requirements. We generally approached the companies’ information center on the show and asked for representatives with such knowledge, experience or background, or have been directly introduced to the right person through their colleagues at the show.

The conversation usually started with a brief introduction to ourselves and to the study, providing the person with an “elevator pitch” presentation and then following with a number of questions that has been articulated beforehand (see appendix: open-ended interview questions). Our sample included visiting and collecting information based on the above strategies as well as conducting interviews/conversations with at least one representative from each of the targeted companies.
2. The show
Targeted companies
Among European manufacturers of heavy vehicles there are major brands, some of them exporting outside European market, some only concentrating in Europe and Asia; including the second-hand market (NOTE: analysis of the second-hand market is not included in the scope of this study). These brands are Scania, Volvo, MAN, Mercedes, Renault, DAF, and IVECO, among which Volvo and Mercedes (now its bus and trucks brands are operating under Daimler) both sell globally, covering all continents. MAN and Scania also have global sales, but they are not present in the North American market, and other brands (Renault, DAF, and IVECO) are only sold on the European market. The IAA show was not limited to the bus and trucks manufacturers, but also a wide range of other related industries such as cabins, trailers, bodies, containers, tires and wheels equipment producers, braking and safety systems, emissions and exhaust-gas after treatment technologies providers, engine parts manufacturers as well as suppliers to the main heavy vehicle manufacturers.

Our focus, however, was mainly on the manufacturers of the entire vehicles (i.e. Volvo, Scania, MAN, Mercedes, Renault Trucks, DAF and IVECO). Nevertheless, we collected some data from a number of suppliers as well, which are presented in the later parts of this report.

Structure of OEM’s ownership
The ownership structures in the heavy vehicle industry are sometimes complex as there are a large number of joint ventures, subsidiaries and even competing brands which are working under the same parent companies, which are also subject to change constantly and being taken over by other companies. Below, there is a graphic representation of ownership structure of major European heavy vehicle companies (figure 2 to 6). For instance, MAN and Scania are now working under the ownership of the same company Volkswagen (fig. 3, volkswagenag.com). Volvo is running Renault trucks as well as Mack trucks, Prevost and Nova Bus in the United States, UD trucks in Japan and Eicher in India (fig. 4, volvogroup.com), while IVECO is held by Fiat Industrial (fig 5, fiatindustrial.com) and Mercedes buses and trucks are being run under Daimler’s ownership together with other brands such as Mitsubishi Fuso Truck and Bus Corporation from Japan as well as Western Star, Freight Liner and Thomas Built Buses in the United States and more recently BharatBenz in India to be produced and sold especially for the booming Indian market (fig. 6, daimler.com). As for DAF, the company first acquired Leyland trucks of the UK, which then upon the bankruptcy of DAF NV, both were acquired by the American heavy duty manufacturer PACCAR to which they are both subsidiaries since 1996 and 1998 respectively (fig. 7, daf.com; leylandtrucks ltd.co.uk; paccar.com)
Fig2: The ownership structure of Volvo Trucks/Buses worldwide

Fig3: The ownership structure of VW, SCANIA, MAN

Fig4: The ownership structure of FIAT/IVECO

Fig5: The ownership structure of Daimler/Mercedes

Fig6: The ownership structure of PACCAR, DAF, Leyland
Remarks from targeted companies and their representatives
Following are the summary of our visit to the companies’ stands at the IAA 64th exhibition and talking to their representatives, listening to their presentations and asking questions related to the emissions control regulations and its implications on technology and innovation. Our main focus was concerned about the European emission standards and in particular, the Euro VI standard which was also the main issue for all truck and bus manufacturing companies in the motor show. The terms, efficiency, eco and green were other buzz words mostly heard in their presentations or were being seen in their marketing materials. Using the EU6 label was a clear sign for companies to show their commitment to the environment as well as expressing their capabilities in meeting regulatory standards and tough requirements imposed by the EU standards as well as showing their innovativeness and staying on the top of trends with advanced technologies that could be brought to the market by the means of intensive R&D investment and innovative product development.

3. EuroVI standards and the European HV manufacturers
Following, are the results of our observations from the IAA show and also conversations with the representatives of major European heavy vehicle manufacturers, their status and position with regards to the upcoming Euro VI emissions control standards:

Volvo
One quarter of the Hall number 17 was the territory of Volvo buses, trucks and financial services with a huge projector screen that was showing latest technological advancements for Volvo products. Other means of communication also included interactive screens installed on a large stage that visitors could browse through the technical information of Volvo products while watching demonstrations projected on the big screen in front of them. On one side of the stage, there were newly developed diesel engines and powertrains, including two Euro VI- compatible engines, D13, which is based on the prior Euro V engines, and a newly developed engine to meet the requirements of Euro VI. Both engines have been already developed and the company has already started receiving orders to be delivered from the spring/summer of 2013. In the transmission side, the company also demonstrated a fully functioning prototype of the newly developed gearbox that sought to add more smoothness in driving the vehicle as well as increasing fuel efficiency as a result of that. In the right corner of the stage, there was an information center which provided complementary information as well as helping us to find the right person to ask further questions about the development of the new engines. The company also demonstrated a number of complete buses and trucks together with the new individual front suspension for the Volvo FH series, which according to the company is the world’s first heavy truck with individual front suspension (IFS) coupled with rack and pinion steering.
We asked for a short conversation with the representative person from Volvo to explain the new technologies used for the development of new engines capable of meeting EU VI requirements, and its related challenges. Following are brief aspects of these challenges in compare to Euro V:

- **The EGR (Exhaust Gas Recirculation) system**: According to our conversation with the company representative, Volvo will continue to make use of EGR systems because they think that further development of cleaner engine technologies will require them to possess knowledge and competence on EGR systems and further optimization of this system.

- **Particulate filters with higher degree of accuracy/efficiency**

- **SCR (Selective Catalytic Reduction) combined with EGR to meet the Euro VI requirements**

- **Increase in fuel consumption as a result of EGR system, but the new engine by Volvo made it possible to increase the torque and enabling lower speed engine to reduce fuel consumption**

- **Development of a new gearbox system to make it more efficient with driving and transmission system**

- **Employing Common Rail System to enhance combustion and increasing fuel efficiency**

Application and integration of the above technologies into Volvo heavy vehicles are considered to be partly related to customer needs (with regards to fuel efficiency), but mainly driven by the regulatory requirements and in particular the Euro VI standard.

On the bus side of the show, there was also demonstration of newly developed Volvo 7900 Hybrid City bus and its 9 liter engine with parallel-hybrid powertrain system (see figure 7), a bus which occupied a significant portion of the exhibition area of Volvo Bus Corporation. Volvo is among the first companies to provide fully functioning hybrid heavy vehicles, although it is also followed by other companies such as MAN (see under segment MAN). Whereas the hybrid attained a prominent position in Volvo Bus Corporation’s exhibition, Volvo’s truck divisions did not display any hybrid.

Fig. 7: Volvo 7900 Hybrid City-bus series (left) and its fully demonstrated engine including main powertrain components, electric motor and transmission system (right). *Photo by: Benny Borghei, IAA 64th, Hannover 2012*
Our conversations with a number of representatives from Volvo Bus including Edward Jobson, the Environment Director at Volvo Bus Corporation revealed the following issues regarding hybrid bus applications in city areas. At the time of the Hannover show, Volvo’s accumulated sales of hybrid buses had reached 1000 units. Orders have been signed with customers in more than 20 different countries, including a recent major order of 60 hybrid buses to Curitiba in Brazil. However, Europe still dominates Volvo’s hybrid bus sales and Great Britain is the most significant national market – as many as 400 of Volvo’s hybrid buses have been sold in Great Britain so far. The next hybrid technology-step for Volvo is a plug-in version of its hybrid bus. Field trials will be executed in inner-city traffic in Gothenburg during spring 2013 and Volvo plans for market introduction of their plug-in hybrid bus by 2014.

**Scania**

Scania was located beside Volvo, and jointly the two Swedish heavy vehicle manufacturers occupied almost half of the total space in hall number 17. Scania presented its new heavy vehicles, engines as well as renting and financial services (i.e. fleet management solutions). Like other heavy vehicle manufacturers Scania also brought new products to offer at the IAA show. In particular, new Euro VI gas-powered engines (9-litre inline, 5-cylinder, with 280 and 340 hp - for biogas, natural gas and liquefied gas). These engines use EGR, SCR, XPI (Extra Pressurized Injection) as well as variable geometry turbocharging (VGT) to meet the emissions level requirements of Euro VI.
However, our interview with a representative from IVECO revealed that Scania also had some Euro VI engines that could meet the requirements without EGR. This was further confirmed by representatives from Scania, who argued that exclusion of EGR was possible in a limited range of product applications (depending on operating temperature). According to the company representatives, it was very easy for the company to achieve Euro V emissions, but with Euro VI requirements it was much more difficult to keep the balance between fuel efficiency and the tough emissions control requirements. However, Scania could successfully keep the fuel consumption as low as the Euro V generation while meeting the emissions standards for Euro VI.

Scania’s Euro VI-compliant vehicles are now available on the market and our conversation with another two representatives from the company revealed that so far they have sold 1,000 Euro VI-compliant vehicles and delivered 800 in total. Scania was the first company to register a Euro VI-compliant heavy vehicle in Germany on March 2011, just before its domestic competitor Mercedes which was considered a triumph for the company. The Scania representatives explained their early market entry, prior to the legal requirements (Euro VI will become mandatory 1 Jan 2014) and without any market incentives (the German MAUT system for reduced traffic taxation is not yet settled for Euro VI), stating that limited initial sales will make it possible to verify the technology in the field, ensuring performance and reliability before the major sales and production takes off.
Renault Trucks
Another heavy vehicle manufacturer presented at Hall number 17 was Renault Trucks, under the same roof and side by side with its sister divisions, Volvo Trucks and Volvo Buses. Renault trucks also presented a variety of light, medium and heavy trucks in the show, including its full-electric delivery truck prototypes to be tested in France for the delivery of goods in collaboration with French chain-retailer, Carrefour (see fig. 8, left side). This light truck prototype was specifically designed for urban applications where maneuverability, vehicles noise and emissions are strictly considered by municipalities and citizens. With a total payload of 6 tons the vehicle lost 1.5 tons of its payload by removing the ICE and replacing it with batteries, electric motor and other electric-related components. The company also combines electric technology with internal combustion engine, offering variety of powertrain alternatives from full electric to hybrid and optimized ICE (i.e. a wide range of opti-fuel solutions, see fig 8, right side). Beside the fully electric delivery truck they displayed a refuse truck equipped with the parallel-hybrid powertrain system developed by Volvo Powertrain. However, so far only 10 units of this truck have been delivered for extended field trials and according to Harald Wieching, Director for Product Marketing at Renault Trucks, the commercial viability of this vehicle is still questionable, as it relies on governmental subsidies and/or favorable local regulations.

Renault engineers now put a lot of effort into reduction of fuel consumption. A particular area of focus for Renault trucks is on aerodynamic improvements of its vehicles in order to further enhance fuel efficiency. The company demonstrated this by providing media-rich animations in a small cinematic area on the show for visitors as well as virtual truck simulators where visitors could sit in a simulator cabin and practice eco-driving.

At the Renault Trucks stand there was a big count-down board indicating the date for the renewal of the Renault fleets to the Euro VI engines as of June 2013. During our visit to Renault Trucks stand area, we also had the opportunity to meet representatives from Renault Trucks. There, our conversation with Harald Wieching, revealed that at the moment there is not much interest from heavy vehicle manufacturing companies to introduce Euro VI engines into the market. The primary reason according to him was that
there is not much incentive to support the market for the introduction of Euro VI generation of vehicles. This was also confirmed by other company representatives we talked at the show (i.e. MAN, Mercedes, DAF). The product marketing director at Renault Trucks also provided other reasons that are affected by the Euro VI measures such as lower fuel efficiency and losing 200kg of payload to their trucks as a result of adding extra weight for emissions control technologies (e.g. SCR, EGR, etc.) as well as affecting the second life of the truck with regards to fuel quality, maintenance, and infrastructure in less developed economies which all together made such as condition that “it doesn’t make sense to introduce Euro VI” according to him (Harald Wieching, 25 Sep., 2012 – The IAA 64th show, Renault Trucks Stand, Hanover, Germany).

The company representative also described technical details of their 11 liter group-engine (Volvo) which used common rail system, EGR (non-cold EGR to avoid emissions in cold start mode), SCR, turbo charger, particulate filter and the use of 7th valve for its regeneration, programmed gearbox for more optimized driving, as well as improved aerodynamics. Among the main technical challenges related to Euro VI for Renault was high temperature, cold engine emissions as well as maintaining the fuel efficiency as Euro V. However, he mentioned that drivers need to be trained to drive with Euro VI-compatible vehicles in order to be able to keep the fuel consumption as low as Euro V levels! Another interesting comment from the interview was that the company has less interest in entering the hybrid technology even though there electric light duty vehicle prototypes, Renault seems to rather choose full-electric powertrain rather than electric-hybrid solutions. Nevertheless, other hybrid solutions such as CNG and LNG are considered as possible technological alternatives.

IVECO
Awarded as the 2013 Truck of the Year at the IAA 64th, IVECO presented its new products on Hall no. 16 just beside its Italian family companies, Fiat and FPT Industrial (from which IVECO sourced its Hi-eSCR technology). According to our conversation with the chief product manager at IVECO in Germany, the reason for customers to choose it as the best truck for the next coming year, 2013, was three-fold:

- First its simplicity of using a highly efficient SCR system
- Second is in fuel efficiency
- And the third was the convenient cab design for the drivers

In fact, the simplicity of the highly efficient SCR (Hi-eSCR) of IVECO resulted in the elimination of a number of complicated solutions that could otherwise increase the weight, reduce flexibility as well as affecting fuel efficiency of its vehicles (see figure 9 left
side: the Hi-eSCR symbolic demonstration and right side: The award winning Stralis Hi-Way truck of the year 2013). According to Mr. Reiner Dellori, one of the major achievements of IVECO in its Euro VI-compatible trucks was that they could reach the required emissions levels without suing an EGR system, and the explanation lies behind the Hi-eSCR that could efficiently reduce NOx to the acceptable levels required by Euro VI standard. That in turn enabled them to focus on increasing fuel efficiencies of the internal combustion engine, increasing engine power and to reduce the capacity of the cylinder and thus bringing down fuel consumption as well as CO2 emissions. According to him, IVECO was the first heavy vehicle manufacturer to meet Euro VI emissions level without EGR, followed by Scania in the second place.

When asked about challenges to meet the Euro VI emissions standard, Mr. Dellori mentioned a number of aspects such as reducing the NOx in the right way as well as challenges to switch from conventional injection nozzles to the high pressure common rail system with approximately 2,200 bar. Nevertheless, maintaining fuel efficiency was one of the main challenges for the company, but still 3% more efficient than other companies (according to him). Further, in the marketing materials provided by the company at the show, there were more details on technological innovations that the company attained to meet the Euro VI requirements:

“The «SCR-Only» system sees the introduction of new generation after-treatment hardware that is the result of intensive research activities by FPT Industrial protected by a number of significant patented solutions....Key to the optimization of combustion efficiency is high mean effective cylinder pressure and high injector nozzle pressures. To achieve these aims, important changes to the crankcase and cylinder head designs incorporate increased structural rigidity, higher coolant flow capacity and increased swept volume.... A new electronic control unit has been introduced to manage both engine parameters and accurate control of the after-treatment system.”
In more detail the system is composed of the following elements, according to FPT¹:
- The Diesel Oxidation Catalyst (DOC)
- The Passive Diesel Particulate Filter (DPF)
- The AdBlue dosing module.
- The AdBlue mixer
- The Selective Catalytic Reduction (SCR)
- The Clean Up Catalyst (CUC)

The whole system is fitted with a network of integrated sensors to control the NOx and any excess of NH3 (ammonia) emitted.

For us it was interesting to realize that among many, only one company chose to go along with such technical solution to meet Euro VI requirements. Thus we asked other companies about the reliability of such solution and why don’t others adapt such approach in their engine technologies. The response from Scania was that they have made it already in some of their small engines (6-9 liters), but not for the larger ones. The explanation from Volvo was that they need to keep their technological capabilities advanced and updated with EGR technology because later on they will need that competence to meet more stringent regulations further on. Finally, our conversation with Mr. Dellori revealed that the Euro VI-compliant vehicles of IVECO are expected to reach the market by January 2013.

DAF
Located in Hall number 17 together with Paccar, its American parent company, DAF presented its new Euro VI trucks based on PACCAR MX-13 engines to which it has employed a number of commonly available technologies which were also used by other companies such as SCR, EGR, common rail fuel injection technology, DeNOx catalytic converter and DPF, as well as changes into chassis and the airflow system to alleviate extra heating resulted from the EGR system to meet the Euro VI requirements. What was interesting to hear from the representative for product marketing from DAF was that, as he explained, it took around 15 years to build up such competence for the company to achieve the required measures from Euro III to Euro VI. This number may alternatively refer to the time interval between the introduction of Euro III in 2000 and the expected implementation of Euro VI in the year 2014; as even now DAF itself doesn’t seem to have the required capabilities to develop Euro VI-compliant powertrain and for that it relies on the engines which are sourced from its parent company, PACCAR. When discussing more about the prospects of the new standards, the company did not even show any interest in actual implementation of such stringent regulations to the market. According to our conversation with the company representative at the show, for DAF it was the matter of selling more Euro V compliant vehicles before the legal enforcement of the Euro

VI into the market. Nevertheless the company announced that they are going to put their new Euro 6 XF product range into production by the spring 2013.

**Fig. 12: DAF new XF Euro VI series**

**MAN**
The MAN’s stand together with VW occupied majority of hall number 12 at the IAA show. It was a large area covered by a wide range of products from both companies including buses, trucks as well as light and medium commercial vehicles (including passenger vans from VW). Interestingly there were concept trucks by MAN with a VW brand that was especially targeting the South American market presented at the show (fig. 13). More interestingly, the powertrain for these trucks was sourced from Cummins based on their Euro V engines technology, using SCR system provided by MAN and leaving the role of VW as an assembler or perhaps as an integrator of off-the-shelf technologies for this special type of semitrailer tractor.

**Figure 13: MAN Trucks with VW brand targeting the S.A. market**
*Source: [http://iaa2012.mantruckandbus.com](http://iaa2012.mantruckandbus.com)*
MAN was also quite active in showing vehicles running on alternative fuels and with alternative powertrain technologies. Figure 14 shows city buses applying hybrid-electric technologies and CNG. It is worthy to mention that MAN’s applications of hybrid-electric technology are primarily based on **series-hybrid** configurations.

![Fig. 14: MAN city buses (right: CNG, left: hybrid-electric)](image)

Photo: Benny Borghei, IAA Hanover-Germany

On the trucks side MAN also appeared quite expressively with a wide range of products surrounding all over the place in the exhibition hall and representatives describing the products both technically and commercially. One of the representatives we had conversation in particular about the technological challenges regarding Euro VI emissions standard explained that the company mainly leveraged its already existing Euro V-compliant engines to meet the new requirements. However, it had to go through extensive testing, validation and optimization efforts in order to keep the fuel consumption as low as the Euro V levels, which according to her was lowest among all Euro V trucks (Jeniffer Kraft-Garcia, Product Management TGX-MAN Europe). Another indication of such extensive efforts is reflected in the amount of R&D investments, which according to her up to 70-80% of the total R&D budget, time and resources can be estimated to be spent only to cope with the emissions requirements of the Euro VI standard.

![Fig15: MAN Euro6 Trucks, Photo by Benny Borghei IAA 64th](image)
Meeting the Euro VI requirements not only had implications on physical attributes of MAN’s trucks such as weight (+200 kg), aerodynamics and engine ventilations, but also imposed lots of time, investments and engineering efforts to develop software and electronic control systems to monitor the after treatment and emissions control equipment. That was the reason why MAN is a bit late (in comparison to its competitors such as Scania and Daimler-Mercedes) in introducing its Euro VI generation of trucks, combined with a restrained approach to let the technologies become matured before it is tried out in the market, according to MS. Kraft. Nevertheless, to cope with the Euro VI challenges MAN used similar technological solutions such as SCR, EGR turbo chargers, DPF, etc. However, these extra costs, additional components and complexities of the auxiliary systems in Euro VI-compliant vehicles still seem quite difficult to be justified for the customers unless there are strong incentives or government promotions as we heard from MAN and also repeatedly from other manufacturers (i.e. Renault, Mercedes, and DAF). Nevertheless MAN is going to start its early sales by October/November 2012 and first market would be the UK, where the company has also made its field tests. The company expects to continue selling the Euro V vehicles until October next year when the new MAUT system will be introduced in Germany and would perhaps make it more economically viable for customers to accept the extra costs of Euro VI-compliant trucks.

**Daimler-Mercedes**

The group of Daimler and its affiliated companies (as presented in figure 5) together occupied hall number 14 and 15 in a vast area demonstrating a wide range of light, medium and heavy duty vehicles with a variety of technologies, ranging from traditional diesel engines to alternative technologies including full electric vans and hybrid-electric distribution trucks, and CNG fuelled buses and trucks. Their Japanese division Mitsubishi Fuso, which produces light-duty trucks and vans, showed a fully electric delivery van as well as a hybrid-electric light duty distribution truck. The latter was equipped with the second generation of Mitsubishi Fuso’s parallel hybrid system and it is currently being introduced on the German market. The first generation has been available on the Japanese market since the mid-2000s. New for the second generation is Li-ion battery technology (Ni-MH was used in the 1st generation) and Dual-Clutch transmission. The vehicle is equipped with a 3l turbo-diesel engine and the power output of the electric motor is 40 kW. According to a representative from Mitsubishi Fuso the payback time for the added investment cost for the hybrid vehicle is about 4-5 years, depending on drive cycles and usage.

**Bus of the year 2013**

The Euro 6 generation of Mercedes Benz CITARO was announced as the winner of the prize for Bus of the year 2013 at IAA-64. According to an interview with the Head of
Daimler Buses (Hartmut Schick\(^2\)), some of the most distinguished features of this new bus are:

- **Eco-friendly**: The bus is not only complying with the Euro VI standard, but also more fuel efficient and "green" as he expressed.
- **Economic**: The bus consumes 5% less fuel in comparison to its previous Euro 5 generation by using regenerative breaking system and electrifying previously mechanic, hydraulic, and pneumatic auxiliaries which in turn will result in less fuel consumption to reduce kinetic motions.
- **Safety and comfort**: There has been much attention on safety of passengers as well as equipment that provide more comfort for the users.

Figure 16 shows pictures of CITARO (the city bus) and SETRA (coach bus) taken at IAA show as well as the bus engine that was exhibited to illustrate the technical innovations employed in developing these buses.

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On the truck side Mercedes also appeared quite strongly, especially with its New Actros brand which was also the winner of truck of the year in 2012. According to the interview we conducted with one of the representatives from the company (Jörg Maier), Mercedes was one of the first commercial vehicle producers who started introducing Euro 6 vehicles in the European market. For instance, according to the company, the technology was already available in 2011 to meet the EU-6 regulation which is going to come into force from early 2014, similarly the company was ready to meet EU-5 standards four years before its official implementation.3

To comply with the stringent environmental regulations, Mercedes employed a technology package called BlueTec since 2005 that combines a number of different technologies such as SCR, EGR (cooled), DPF, XPI as well as common rail injection system. On top of that, Mercedes has also invested quite heavily on vehicle dynamics and cabin optimization that is claimed to have reduced up to 18% of air resistance which can result in 4 to 5 percent less fuel consumption.4 This is also combined with other features offered in new generations of vehicles on Mercedes such as Stop-Start system to reduce fuel consumption in city haulage and high traffic congestions as well as FleetBoard Telematics that aimed at increasing traffic efficiency further on by providing constant feedback to the driver and to the fleet management.

At a seminar on alternative fuels and powertrain technologies Walter Eisele, corporate R&D manager at Daimler AG, argued that there are a number of driving forces pushing this development, including pending regulation on CO2-emissions, inner-city environmental zones, fuel and energy prices and access to fuel, subsidies, competition and customer demands. Moreover, in the coming years Euro 6 requirements will most likely include incentives for alternative fuels and powertrain technologies. He explained that on a short

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4 http://media.daimler.com/dcmedia
term basis, Daimler currently has more faith in hybrid technology than in other alternative powertrain technologies such as fuel cells. Daimler has recently established a global R&D center in Japan with the ambition to benefit from Mitsubishi Fuso’s vast experiences in hybrid technology and make use of this knowledge in other divisions. Daimler develops both series hybrid configurations (for inner-city buses) and parallel hybrid configurations (for trucks). The energy recovery potential (vehicle weight) and drive cycles determine which application areas are suitable for hybrid technology. These are displayed as the shaded boxes in Table 1. Currently Daimler has vehicle R&D projects and field test vehicles in all these applications. However, according to Walter Eisele, so far hybrid technology has only proved itself to be commercially viable in only one of these applications: light-duty distribution (i.e. the Mitsubishi Fuso truck). In other applications the cost is still prohibitive for further commercialization and in particular, the price/performance of batteries is a major hurdle. Financial subsidies are therefore necessary: “Ohne unterstützung will es nicht gehen”.

Table 1 Suitable commercial vehicle applications for hybrid-electric powertrains

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<th>Application</th>
<th>Light-duty</th>
<th>Medium-duty</th>
<th>Heavy-duty</th>
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<td>Distribution/Inner-city</td>
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Daimler/Mercedes did not make much fuss about their Euro VI engines in the exhibition. According to Jörg Maier (Manager of Product strategy and strategic product projects at Daimler AG), Daimler considers Euro VI yesterday’s news. Already last year they introduced the new Actros model range with Euro VI engines (truck of the year 2011) and currently about 20% of their truck sales on the European market are trucks equipped with Euro VI engines. Similar to other major manufacturers the Euro VI requirements forced Daimler/Mercedes to combine a number of technologies, including EGR, common rail fuel injection, SCR, and particulate filters with active regeneration. However, from a market perspective, a problem is that the MAUT incentives for Euro VI engines have been delayed due to lobbying from the Organization of Haulers as well as from some truck manufacturers which have been slower in the development and market introduction of vehicles with Euro VI engines. Now a lot of effort is devoted to fuel consumption. Finding the optimum balance between Nox/PM emissions and fuel efficiency is quite difficult and expensive. In order to reduce fuel consumption, Mercedes has abandoned their V6/V8 engines in favor of in-line engines and they are also developing and implementing electrical auxiliary systems. Other focus areas for R&D are aerodynamics, waste heat recovery, dual fuel systems and hybridization. According to Jörg Maier, everybody will talk about fuel efficiency at next year’s IAA Nutzfahrzeuge due to pending Euro regulation on CO2-emissions.
4. Suppliers

Several suppliers to the automotive industry were present at the IAA Nutzfahrzeuge. Adjacent to the major truck manufacturers were exhibitions from first tier system suppliers such as ZF, Bosch and Voith and as well as more specialized suppliers of emission treatment equipment, including amongst others Eberspräch, Tenneco and Emitec. An observation with regards to vehicle electrification and hybrid-electric powertrains was that the major German system suppliers ZF and Bosch seemed to put more emphasis on these alternative technologies than the major German truck manufacturers did. In particular, Bosch seemed anxious to show their systems capabilities by displaying an interactive simulation of their axle-split system for cars in which the ICE drives the front wheels and electric motor propels the rear wheels. The system switches automatically between rear wheel, front-wheel and four-wheel drive depending on the driving conditions, power needs and battery charge level. Bosch supplies the complete hybrid system, including electric motor, power electronics, battery and control system. The system is already in production (three PSA car models). Bosch is currently developing an integrated hybrid system for heavy commercial vehicle applications, comprising a 120kW electric motor. This is scheduled to be in production by 2016. Currently, Bosch offers different components for electrified vehicles including Electric motors, Charger, High-voltage batteries, Inverters and regenerative breaking components.

ZF displayed a similar hybrid-electric system. However a notable difference is that ZF does not supply the battery system, which the automotive manufacturer has to source from a specialized battery supplier. Hence, by comparison to Bosch, ZF does not take as extensive system integrator responsibilities for the hybrid-electric powertrains.

Several suppliers displayed emission treatment systems for trucks and buses (SCR and particulate filters). The designs of these systems are generally customized to fit different manufacturers’ specifications.
FPT Industrial, the supplier of the Hi-eSCR system to IVECO which won the truck of the year 2013, was also at the show. Both companies (IVECO and FPT) are owned by the mother company FIAT Industrial, while FPT is specialized in powertrains for on-road and off-road vehicles, marine and power generation applications.

In general, suppliers showed so much interest and willingness to get involved in development and manufacturing of Euro VI compatible products by demonstrating their commitment and capabilities to employ advanced technologies. However, when we talked to them they mostly expressed that they will only invest if they see a clear signal from OEMs regarding their commitment for new technologies. For instance, with regards to hybrid applications, some suppliers expressed their interested and willingness to engage in further development of capabilities in this field, but they said that they haven’t yet seen a strong and pervasive move towards hybridization from heavy vehicle manufacturers. They said that we are willing to invest, but it seems that most of European automotive manufacturers have not yet seen a clear advantage in investing in hybrid technologies, or maybe it is not yet the right timing for them to enter into this area of technology.
5. IAA and environmental policies
Apart from the main show and the exhibiting companies, there were a number of policy issues raised during the IAA show in Hanover, of which some of the most important ones are explained here.

Real implementation of Euro VI in the market still not clear
Despite all the commercialization and publicizing for Euro VI products, when talking to most companies, it was still hard for many of companies to believe that their Euro VI-compatible products could be solved easily into the market since the extra costs and little benefits were seem quite hard for the customers to accept.

Our overall understanding from interviews with representatives of those companies is that most companies saw the Euro VI standard as a coercive pressure that they just have to flow not to be left behind in the technology competition and also in their branding and marketing campaigns, but not really as sellable products that they can make profitable plans at the moment. For some companies like Volvo and Daimler complying with the Euro VI standard was the matter of daily business and as presented earlier, they have been in fact able to meet the requirements already for some years now. But for some others it was the matter of huge efforts, testing, verification, etc. nevertheless it was a large proportion of investment for all those firms. For instance, it seemed that MAN had to make so many changes and going into many tests and verification stages that took the company much more time than its competitors (e.g. Daimler) before they are able to introduce their Euro VI products.

Our recent interview with the environment and public affairs representative from Volvo (Niklas Gustavson) revealed that a high portion of total R&D budget in engine and powertrain development in the area of 80% goes to the regulatory compliance. A similar figure was presented from Scania when we interviewed the senior vice president in powertrain development of the company (Jonas Hofstedt). Some sources estimated the development of the Euro6 engine generation and technology to cost Scania around 10 billion SEK and five years of research and development work.

The MAUT system and incentives for early Euro VI applications in Germany
In our interviews, most European companies and almost all German counterparts were seemed quite reliant on European incentives as well as the German MAUT system to make the momentum and help them to sell their Euro VI-compatible products. Our interview with a representative from Daimler (Jörg Maier) revealed that the MAUT system is still waiting for more consensus and needs more political work. In his view, there is yet little potential for the current MAUT system to include Euro VI standard until the next

elections in Germany. He also expressed that there are very diverging opinions both within Germany and within Europe with regards to the real implementation of Euro VI standards. For instance, according to him, while inside Germany Daimler is pro Euro VI (perhaps related to its more advanced technological readiness), MAN still seems reluctant in supporting Euro VI standard. The same is also true when it comes to the German organization of haulage which has not shown a strong support for Euro VI standard. According to him, a similar division also holds true among European countries where advanced economies such as UK, Germany, Sweden Switzerland, and other western countries as well as Nordic states are in favor of Euro VI, while Eastern Europe countries together with Spain and Italy are not in support of more stringent regulations yet.

The ACEA meeting during IIA
Certainly such doubts and concerns were also brought into the attention in the top of the agenda of European heavy vehicle manufacturers and their affiliations in the form of collective opinion and the statements from the industry to be heard by politicians. In this regard, the association of European Automobile Manufacturers (ACEA) which is a Brussels-based trade association composed of the 16 major car, van, truck and bus producers in Europe based had meetings in the occasion of IAA show in Hanover where representatives of European automotive industry gathered and discussed about the future of auto industry in Europe. In particular, the political message from the association concerned the lack of incentives and motivation for fleet owners to switch into Euro VI standard. Specially, the ACEA cautioned that the benefits of the latest emission-reducing technologies will not be realized unless new vehicles are actually put on the roads, which is again dependent on ‘right’ regulatory and political framework to support it. Other main items in the political agenda of the ACEA meeting at IAA included the below remarks by Mr. Harrie Schippers:

- CO2 emissions from trucks cannot be addressed via a ‘one-size-fits-all’ policy
- Policy measures should propel the natural force of customer demand
- Progress must be embedded in a wider effort involving all players
- having a consistent, harmonized and reliable regulatory system


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