Trucks and fuels that make a difference
CleanTruck 2010–2014
Sweden’s largest urban clean vehicle fleet

Stockholm is growing. Today, Stockholm is the only region in the country that can compete with metropolitan regions abroad, such as Berlin, Hamburg and Amsterdam, in terms of the Gross Regional Product. A growing city needs deliveries of goods. A growing population and trade entail a greater need for transports of goods into the city - and a corresponding increase in waste out from the city. This will demand an ever larger part of the available road space. Just as with public transport, it is important that society plan for this necessary goods traffic.

Although heavy traffic only constitutes around one tenth of the vehicles in the county, it accounts for one fifth of all emissions of greenhouse gases. Moreover, the emissions of nitrogen oxides and particulates from heavy traffic make large contributions to degrading the air quality in the city. The goods traffic must therefore be environmentally adapted and here, CleanTruck has really shown the way. With more than five million vehicle-kilometres, run by 50 clean trucks, 18 transport companies in Stockholm have together succeeded in reducing the climate burden by more than 3,400 tonnes of carbon dioxide equivalents. This is comparable to 1,400 cars disappearing from the streets of Stockholm. The project has also considerably reduced nitrogen oxides and particulates and thereby contributed to better air quality in the city.

The City of Stockholm has a route plan for how the city will become fossil-fuel free by 2050. The objective has been honed and the city is now working for a fossil-fuel free vehicle fleet as early as 2040. In the near future, requirements on the transports procured by the City of Stockholm will increase further. In Stockholm, the transports of the future will be clean. Everyone in the transport industry is needed to achieve that objective.

Katarina Luhr
Vice Mayor of Environment
**CleanTruck**

The carbon dioxide emissions from car traffic are decreasing, but for heavy-duty traffic the trend does not look as positive – the emissions of carbon dioxide are increasing due to a growing amount of transports. In the City of Stockholm, heavy-traffic accounts for 4 per cent of the traffic measured as vehicle-kilometres, but for 23 per cent of the emissions (2013). In 2010, the emissions of greenhouse gases from heavy vehicles increased by 44 per cent compared with 1990. At the same time, the share of clean trucks was negligible. Something had to be done to break this negative trend.

**Facilitating the introduction of clean trucks**

CleanTruck was running between 2010 and 2014 and was the first project of its kind for heavy-duty vehicles. The aim was to hasten and facilitate the introduction of trucks with environmentally adapted technology. To get there, the project offered grants to interested distributors to compensate for the clean trucks being more expensive, and to OKQ8/IDS and AGA for establishing infrastructure. Focus was on heavy-duty vehicles in city traffic, and only technologies that were partially or completely unproven could be included in the project.

**Three different kinds of clean truck technologies**

The project included three different truck technologies all of which were on the threshold of market introduction when the project began in 2010:

- **Ethanol ED95**
- **Methane diesel (i.e. methane gas and diesel)**
- **Hybrid electric trucks**

**Climate-smart transport cooling**

The Liquid Carbon Dioxide (LIC) technology (climate-smart transport cooling for refrigerated and frozen goods transports) was already on the market when CleanTruck began – although on a small scale. To introduce the technology, the project offered grants for the incremental costs.

**Nitrogen gas in tyres**

Nitrogen gas in tyres was another technology included in CleanTruck. With the right tyre pressure, fuel consumption is reduced. In addition, wear on the tyres is reduced substantially, which means lower operating costs for the distributor.

**Economical driving**

The driver affects fuel consumption to a high degree through his or her style of driving. CleanTruck included knowledge support as well as cost reimbursement for continued training in economical driving for participating companies.

**Evaluation**

Participating transport companies that invested in clean trucks were offered added-expense compensation to make up for the more costly technology. At the same time, the companies committed to participate in the project’s evaluation and to help distribute information to companies following suit.

**An important link**

CleanTruck constituted an important link between research and development and a full-scale introduction of new environmentally adapted technologies, new filling stations for alternative fuels, filling stations for LIC and equipment for the inflation of tyres with nitrogen gas. The aim of the project was to demonstrate how carbon dioxide emissions and other emissions from the goods transport sector can be reduced by introducing new technologies in heavy vehicles for urban distribution. The project’s experiences should be of sufficient interest to inspire more efforts of a similar nature.

**The driver affects fuel consumption to a high degree through his or her style of driving.**

**Broad endeavour**

Clean trucks and infrastructure for clean fuels were introduced at the same time. In addition, infrastructure for the filling of LIC and nitrogen gas in tyres was introduced. With this concentrated effort, CleanTruck has achieved Sweden’s largest urban clean truck fleet to-date.

**Participating companies**

- Carlsberg Sverige AB
- Carrier Transport AB
- Dafgård
- IL Recycling Service AB
- Kyl- och Frysexpressen
- Per Svensson Transport AB
- Marko Kaj Moving AB
- MTAB
- OLAB AB
- Posten Logistik AB
- Ragn-Sells AB
- Seppos Service AB
- Sita Sverige
- Sodexo
- Svebol Logistics AB
- Svevia Maskin AB
- Trångsunds Åkeri
- Wiklunds Åkeri AB

**Activities within CleanTruck**

- Installation and operation of a public fuel station for liquid and compressed methane gas.
- Two filling stations for liquid carbon dioxide (LIC).
- Four sets of mobile filling equipment for nitrogen gas for tyres.
- Enabling the purchase/leasing of 15 ethanol ED95 trucks, 18 methane diesel trucks, 17 hybrid electric trucks and five refrigeration units for LIC refrigeration at 18 different transport companies in Stockholm.
- Training in and driver support for economical driving.
- Creating a network of companies willing to invest in new clean transports.
- Marketing and utilisation of the results.
- Measurement and evaluation.

**Compensation of incremental costs to lower the threshold**

During the project, there was an opportunity for interested transport companies to obtain compensation for the higher purchase cost of the clean trucks. The compensation was provided by EU Life+, Vinnova and the Swedish Energy Agency and amounted to 50 per cent of the incremental costs compared with a comparable, conventional diesel truck, though maximised to SEK 50,000 per ethanol truck, SEK 300,000 per hybrid electric truck and SEK 125,000 per methane diesel truck. In addition, CleanTruck contributed SEK 6,400 to purchases of refrigeration units for LIC refrigeration and SEK 2,800 for training in economical driving or for the purchase of technical equipment for economical driving.

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**Image 637x407 to 809x604**

**Participating companies**

- Carlsberg Sverige AB
- Carrier Transport AB
- Dafgård
- IL Recycling Service AB
- Kyl- och Frysexpressen
- Per Svensson Transport AB

**CleanTruck**

**City of Stockholm, AGA and OKQ8/IDS**

- The Environmental & Health Administration of the City of Stockholm coordinated the project and was responsible for project management. AGA was responsible for the construction of Stockholm’s first filling station for liquid and compressed gas as well as filling stations for LIC and nitrogen gas. OKQ8/IDS invested in the world’s first public fuel facility for ethanol diesel ED95.
- 18 private transport companies participated in the project. In total, the participating companies purchased 50 clean trucks and five refrigeration units for LIC. The trucks were used for waste collection, construction, and goods and product distribution in Stockholm.
- CleanTruck was financed with the support of the European Union environmental programme LIFE+*, Vinnova and the Swedish Energy Agency.
Methane diesel trucks: Flexible for regional transports

How it works

A methane diesel truck uses two fuels (dual-fuel solution): diesel and methane gas in an adapted diesel engine. To run a diesel engine on vehicle gas, it has been equipped with gas injectors and a specially adapted catalytic converter.

The methane gas and the diesel are filled in two separate tanks. The modified diesel engine always starts on diesel, but gradually diesel consumption is reduced. In optimal driving cycles, only a small portion of diesel is used to ignite the gas-air mix. With this technology, up to 70-80 per cent of the diesel consumption can be replaced with gas, depending on driving cycles.

In regional traffic, the proportion of gas is the highest. In urban driving with many starts and stops, the truck operates purely on diesel. Vehicle gas is methane gas (CH4) consisting of natural gas, biogas or combinations of the two. In some truck models, gaseous fuel is filled in a pressurised tank, while other models use gas in liquid form. It is beneficial for trucks that drive in local or regional traffic to be filled with compressed gas. Trucks in long-distance traffic are preferably filled with gas in liquid form, which has considerably greater energy content and thereby provides a longer driving distance per tank.

The carbon dioxide that is formed when biogas is burned and mixed with the oxygen in the air contributes very little to the greenhouse effect. If the methane diesel trucks use pure biogas, the greenhouse gas emissions are reduced by up to 80 per cent compared with a conventional diesel truck. However, even Stockholm vehicle gas, which includes 35% fossil natural gas, provides a good reduction of greenhouse gases.

The methane diesel trucks in CleanTruck have resulted in 18 methane diesel trucks at 11 transport companies in the Stockholm region. All of the vehicles use compressed gas. The first methane diesel trucks in CleanTruck were delivered in spring 2010 and some were also included in a large field test conducted by Volvo. The truck was put into regular production in 2011 and began to be delivered in the latter part of 2011.

The vehicle has functioned well and the participating companies are generally very satisfied. The drivers do not perceive it to be a problem to fill two different fuels – as long as there is a good supply of vehicle gas. On the other hand, the vehicle can run on diesel alone, in the event of a gas shortage, which decreases the vulnerability substantially.

147 thousand km has been covered by the methane diesel trucks.

Experiences from CleanTruck

Methane diesel trucks:

- reduce CO2eq by between 0 and 41 per cent compared with conventional diesel trucks
- reduced CO2eq by a total of 350 tonnes during the project period (on condition that the methane diesel trucks have roughly the same energy consumption as diesel trucks)
- have an extra cost of SEK 250,000 compared with a conventional diesel truck
- are best suited for long-distance and regional transport
- are less suited for city transport with short driving cycles including many starts and stops
- have covered between 80,000 and 600,000 km per vehicle, which is 1,470,000 km in total.

Facts

Supply

In many countries, the gas is already available at public filling stations and the infrastructure is getting better and better. The supply of vehicle gas has, however, been a major problem in the Stockholm region, but since the CleanTruck filling station for heavy vehicles opened in Alvik in 2012, the situation has become considerably better. The filling station is owned by AGA and operated by ÖkQ8/IDS.

Vehicle gas

Vehicle gas is the collective name for natural gas and biogas for use as fuel in vehicles. Natural gas is a fossil fuel while biogas is produced from biologically renewable materials, such as waste. The gas mixture is also available in two forms: liquefied gas (LNG/LBG) with a temperature of −162 °C (−260 °F) and pressurised compressed vehicle gas (CNG/CBG).

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For reduced fossil fuel consumption

The brewery giant Carlsberg takes care of 90 per cent of its end customer distribution under its own custody. The transports are therefore an important part of the company’s operations. CleanTruck gave Carlsberg the possibility of investing in methane diesel trucks. It was an easy decision to be involved in the project.

Facilitating the introduction of clean trucks

“We want to be involved and take our responsibility,” explains Gabriel Treschow, Fleet Manager at Carlsberg Sweden.

Carlsberg received its methane diesel truck in the beginning of 2013. The truck is used to drive cargo from the depot in Haninge and further south, towards Ginesta and Södertälje, among other destinations. The methane diesel truck is solely used for regional distribution.

Maximum gas operation with fewer stops

Per Svensson Transport has also invested in methane diesel trucks in the scope of CleanTruck. The company transports groceries in the inner city of Stockholm for among others ICA and DB Schenker. Per Svensson, MD and owner of the haulage company, is generally very satisfied with the methane diesel trucks, but had hoped that the trucks would be able to run on a larger proportion of gas:

“The engine has to warm up in order to shift to gas operation. When there are queues in the inner city, it happens that the engine doesn’t have time to get warm enough and then it goes over to diesel instead, which is a shame.”

But Per Svensson Transport has nonetheless succeeded in reducing the emissions from its transports – in large part thanks to the methane diesel trucks:

“We strive to continuously reduce the emissions from our vehicles. In our annual follow-up of fuel consumption, we have reduced the total consumption every year – and the methane diesel trucks contribute a great deal to the total reduction,” explains Per.

Modern truck with outdated infrastructure

Even for Carlsberg, it is clear that the methane diesel truck has a lower environmental impact than a conventional diesel truck. The truck is perceived as modern and has to-date functioned without problem. However, the filling of gas does not work optimally:

“The infrastructure does not really work like it should. There is not enough pressure in the pump. The truck’s gas tank can pretty much never be fully filled. The tank is only filled to around 85-90 per cent. The equipment at the stations simply can’t handle more. It might not seem to be a big thing, but when filling every ten days, those 10-15 per cent are important – they cost us and the driver valuable time,” explains Gabriel.

Importance of CleanTruck

Both Per and Gabriel emphasizes the importance of CleanTruck as a project like CleanTruck. The project has made positive contributions to lowering the threshold for replacing conventional diesel vehicles with other vehicle technologies.

“There is a readiness to accept some extra costs, but the support from CleanTruck helped out so that we were able to make the decision to purchase the methane diesel trucks,” says Per.

Another very important part of CleanTruck has been the possibility of meeting other companies and distributors:

“One strength is the meetings with other distributors and vehicle users. Being able to exchange knowledge and being able to hear about others’ experiences is valuable. CleanTruck has been an excellent forum,” says Gabriel.

ED95-trucks: Reliable with high climate benefit

A n ethanol truck has the same kind of combustion engine as a diesel truck. The fuel used is called ED95 and consists of 95 per cent ethanol and 5 per cent additives in the form of ignition improvers, lubricants and corrosion inhibitors. The additives are necessary for the fuel to work in an engine without spark plugs. In a diesel engine adapted for ED95, the potential of the ethanol is utilised up to 40 per cent better than in a spark ignition engine. An ethanol diesel truck can only be driven on the ED95 fuel.

An ethanol diesel truck functions exactly like a regular diesel truck. The ethanol truck uses more fuel by volume per kilometre, since ethanol has a lower energy content than diesel. In other words, the ethanol truck consumes more fuel but energy-wise, the consumption is the same.

Since ethanol is a solvent that dissolves both oil and other deposits, more frequent service is needed than with conventional diesel trucks. There were an extra two to three service stops per year at the beginning of the project, but during the project, the engine manufacturer reduced the the extra number of service stops to one or two per year. Compared with conventional diesel engines, the CleanTruck trucks reduced emissions of fossil carbon dioxide by 65–70 per cent when running on ED95. The environmental performance depends on how the ethanol is produced and how the by-products are used. The best ethanol used in Sweden reduces emissions by as much as 90–95 per cent.

The ED95 ethanol used during the Clean Truck project is produced by SEKAB in Örnsköldsvik and has a stated carbon dioxide reduction of 66 per cent compared with a regular diesel MK 1 B5/B7. Early on in the project (2011-2012), SEKAB also supplied ethanol produced from forest waste with a carbon dioxide reduction of just over 90 per cent.

ED95 in CleanTruck

Within CleanTruck, the world’s first public filling solution for ED95 opened in Jordbro in the Municipality of Haninge where many logistics companies are located. There has also been an opportunity for companies to have a private filling solution in cooperation with SEKAB. Refrigerated transport provider Kyl- och Friys- expressen is the only company that chose to invest in ED95 trucks in the scope of CleanTruck and currently has a total of 15 trucks.

Well-tried technology

ED95 is not new in the transport sector, but has been used in city buses since the end of the 1980s. Among other things, public transport operator Storstockholms Lokaltrafik has nearly 600 ethanol buses in operation.
Facts

Etanol
Ethanol is by far the largest biofuel in the world. Ranked globally, ethanol accounts for more than 80 per cent of the consumption of biofuel. Ethanol as a fuel exists in various forms, of which low-blend E5 and E85 currently are the most common in Sweden.

E85 consists of ethanol and petrol and is a fuel for petrol engines with Otto technology (spark ignition technology) with some modification of the engine and injection system. Dehydrated ethanol is fully mixable with petrol and all Swedish petrol currently contains 5 per cent ethanol.

ED95 is 95% pure ethanol with an additive of ignition improvers. Just like diesel engines, engines for ED95 are based on compression technology, which entails up to 30 per cent higher efficiency compared with Otto engines.

Ethanol can be made from many products, such as waste in the form of dairy and bakery products, wine and juice surplus. Most common in Europe is surplus agricultural products. The production of ethanol from cellulose is under way as pilot projects in Brazil and the US, as well as in Sweden and Finland. Globally, sugar cane on abandoned and degraded land accounts for a large share of the feedstock for ethanol.

Experiences from CleanTruck
The ED95-trucks...
... reduce CO2eq by 68 per cent compared with conventional diesel trucks
... have an extra cost of SEK 100,000 compared with a conventional diesel truck
... reduced CO2eq by a total of 2,960 tonnes during the project period
... are best suited for city distribution
... have covered between 22,000 and 310,000 km, which is 2,000,000 km in total.

Major environmental gain at a low price
Kyl- och Frysexpressen has the ambition of being Sweden’s leading distributor in terms of minimising environmental impact. With the help of CleanTruck, they got a push forward in their work on finding an alternative fuel for the diesel trucks.

First out
Kyl- och Frysexpressen was the transport company that chose to test ED95 ethanol in the scope of CleanTruck. Today, 15 of the haulier’s 70 trucks run on ED95.

“We use the ethanol trucks in the same way as the regular diesel trucks; there’s no difference. However, the ED95 trucks only run for ICA since we made this investment together with them,” explains Robert.

Kyl- och Frysexpressen received the first ED95 trucks in April 2010. By and by more trucks have been purchased and today, they cover ICA’s entire delivery needs in the inner city of Stockholm.

Sharply reduced emissions
Running the trucks on ED95 instead of regular diesel trucks means a sharp reduction of carbon dioxide emissions - at a relatively low cost.

“We have a nearly 70 per cent reduction in the carbon dioxide emissions for these transports. So the environmental gain is the absolutely largest advantage of the ED95 trucks. However, the trucks must go in for service more often than regular diesel trucks, around two times more per year. We can nonetheless see that the trucks running on ED95 only entail an additional cost of a few per cent, which we see as a very inexpensive environmental investment,” says Robert.

Because the vehicles are only operated in Stockholm and thereby relatively short distances, filling with around 200 litres of ED95 every second day suffices. To facilitate the filling of the 15 ED95 trucks, Kyl- och Frysexpressen has set up its own pump at its terminal in Årsta.

ED95 also in the future
Kyl- och Frysexpressen considers the investment in ED95 trucks successful. The drivers are satisfied, emissions of carbon dioxide are decreasing and the price is low despite the environmental gain being large.

“After having driven ED95 trucks for a few years now, we still think that ED95 is the best alternative fuel by far. Of the solutions that currently exist, there is no reason to look for anything else,” concludes Robert.

Supply
In September 2011, Jordbro Industrial Park south of Stockholm received the world’s first public filling station for ED95 ethanol. Jordbro Industrial Park is one of the county’s largest logistics hubs for convenience goods, which means that the fuel became available for a large number of trucks that traffic the park daily.

15 Scania P 270 hp drive food transports. 3 two-axle trucks, 12 bogie trucks. The payload capacity varies from 7.8 to 14.3 tonnes.
The hybrid electric technology has long been established among car makers. It is now increasingly coming in transport vehicles, both light and heavy duty trucks. In a hybrid electric truck, an electric motor works together with a regular diesel engine. The truck is equipped with a special high-power battery and an electric motor that helps power the vehicle together with the regular diesel engine. When driving, both of the motors work to power the truck, either at the same time or individually. Hybrid electric trucks use the combustion engine and a generator to charge the battery while driving, but also brake and retarder energy (auxiliary brake) can be used for charging. Some of the energy that turns into waste heat in a regular truck can hence be utilised to power the electric motor. This means that the vehicle's energy consumption can be reduced by 10–30 per cent, depending on driving style and driving cycle.

Hybrid electric trucks in CleanTruck
Interest in hybrid electric trucks was initially very low among the CleanTruck companies, mainly due to the high additional cost compared with conventional trucks. The project then raised the compensation from SEK 100,000 to SEK 300,000 which provided results. More and more companies became interested in the technology and ultimately, a total of 10 transport companies invested in 17 hybrid electric trucks from Volvo, Mercedes-Benz and DAF. In CleanTruck, the hybrid electric trucks were used in varying transport assignments; waste collection, goods deliveries, building logistics, Truck-Mounted-Attenuator (TMA) service vehicles for goods deliveries at night (Off Peak). It has been good for the evaluation to get reports on so many vehicles in a wide range of transport assignments.

Hybrid electric trucks: Quiet and clean in the dense city

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12 13

17 trucks: 8 DAF 160 hp, 2 Mercedes 218 hp, 7 Volvo 306/336 hp.
15 two-axle trucks, 3 bogie trucks. The payload capacity varies from 3.7 to 13.9 tonnes.

Experiences from CleanTruck
The hybrid electric trucks...
... reduce CO2eq by 15 per cent compared with conventional diesel trucks*
... have an extra cost of SEK 600,000 compared with a conventional diesel truck
... reduced CO2eq by a total of 96 tonnes during the project period
... are best suited to city distribution and where low noise levels are required
... have covered between 520 (due to late delivery) and 98,000 km, which is 610,000 km in total
... require that the vehicle runs with both at even and high speed with a lot of braking, but as few starts as possible in order to achieve the goal of maximal use of electrical operations.

*Fuel consumption in hybrid electric trucks do not correlate to known variables, such as permitted load, stated tonnage, automatic/manual gear box, bogies/single-axle, length, bodywork or engine size. The most likely is that the traffic rhythm on the route driven and the individual driving style are what most determine the carbon dioxide savings for hybrid electric trucks.
The clean truck that delivers in silence – the truck to proudly sneak with

Wiklund's Åkeri has bought all their five hybrid electric trucks from DAF in the scope of CleanTruck. The trucks are largely used for transports in construction logistics. One of the vehicles begins, for example, every morning from Wiklund's logistics centre in Bro depot and then traffics the entire region with deliveries of drill steel to workplaces below and above ground.

“The hybrid electric trucks are smaller than the rest of our vehicle fleet. We have several different vehicle types, and hybrid electric trucks are among the smaller ones. They are therefore best suited for lighter transports,” explains Nina Neuman, Quality and Environmental Manager at Wiklund's Åkeri.

Operational reliability is crucial

According to Nina, the technology has worked well. The operational disruptions that have arisen are not more than what conventional trucks are struck by. High operational reliability is crucial since idle trucks rapidly become costly for the haulier.

“The operational reliability is the most important for us. The reason that we chose to invest in hybrid electric trucks was the dual technology. You then always have the diesel technology to fall back on that you know works. According to the drivers themselves, the hybrid electric trucks are not especially cool trucks with big engines. More and more drivers emphasize the advantages of reduced noise and the fact that the environmental aspects becoming increasingly more important for many.”

Importance of the “right” economical driving

According to Nina, the diesel consumption has not been very much lower with the hybrid electric trucks compared with conventional trucks - how the trucks are driven is namely crucial. Hybrid electric trucks require a different driving technique than what is taught in traditional training in economical driving. At Wiklund's Åkeri, they are planning to reduce the diesel consumption by training the drivers in the art of driving hybrid electric trucks economically.

“We will train our drivers in how to drive so that the batteries will be charged as effectively as possible and the vehicle will run on electricity to the furthest possible extent. We need to get better at using the electrical energy,” explains Nina.

Hybrid electric trucks enable night driving

Svebol Logistics have also bought a hybrid electric truck in the scope of CleanTruck. The truck delivers goods for Lidl in central Stockholm and is the only one of its kind to have an exemption to drive in the city at night as the noise level for the hybrid electric truck is considerably lower than for conventional trucks.

“It was this truck that made it possible for us to get this exemption. This truck operates in a development project for the City of Stockholm that aims to increase utilisation of the road space. The project is called Off Peak, and CleanTruck was the enabler of this project,” explains Svebol Logistics’ owner Martin Svedin.

Besides the hybrid electric trucks considerably improving the work environment for the drivers by being very quiet, the night driving also contributes to less stress.

“A driver who drives in the city during the day has a very hectic environment. But we now gain access to the same road space, but at a time when it is not at all as hectic. So for the driver’s work environment, it is very valuable,” says Martin.
Transportbuyers are important

The distributors are not the only stakeholders in the transition to a clean truck fleet. The forwarding agents and goods owners also constitute important parts of the whole. DB Schenker has a business concept that is based on not owning any means of transport, but rather tying various shipping companies, airlines, hauliers and railway companies together - and then packaging and selling the transport service as a whole.

In other words, as a forwarding agent, they serve as a middle man between the transporters and the goods owners.

From an environmental perspective, DB Schenker works in part by ensuring that the capacity level is as high as possible in all transports. A truck that drives goods to Gothenburg shall not go empty back to Stockholm. But DB Schenker also has another important role to play in the environmental efforts:

“We have a very large possibility to influence by setting relevant and realistic environmental requirements on the hauliers that drive for us. We continuously stay updated on what is on the market and what is doable, and then we reframe to it to the requirements that we incorporate into our transport agreements,” explains Monica Jadsén Holm, Environmental Manager at DB Schenker.

Incentives from many directions

The hauliers cannot themselves take the entire responsibility to convert to a clean truck fleet. In order for it to be a real transition, the introduction of new, alternative technology must be stimulated by various stakeholders. According to Monica Jadsén Holm, CleanTruck is a good example of such an initiative:

“Vehicles with new environmental technology are more expensive for the vehicle manufacturers to produce and thereby more expensive for the companies to purchase. Some clean trucks are also more costly in service, there may be uncertainty regarding the second hand value and there may also be questions regarding the infrastructure of the fuel. All of this means that the new vehicles must be helped to enter the market - in one way or other. And then offering a grant as has been done in CleanTruck is - and there may also be questions regarding the parameter - the consumers do not accept empty shelves in the store.

In the hope of finding alternative transport options, ICA joined CleanTruck together with Kyl- och Frysexpressen and tested ED95 trucks. And the results exceeded expectations.

“The test with ED95 has turned out very well. The effort caused no technical difficulties and generated CO2-savings and has also been cost effective,” explains Per Andersson, OpEx Manager at ICA Sverige AB.

An important starting point

For ICA, CleanTruck meant an important step to dare to try something new. But they do not just leap back in satisfaction. In its capacity as a goods owner, ICA continues to play a central role in the environmental efforts according to Per. “We are important to pushing the environmental issue. It won’t happen without us taking action. We must set clear demands and we do so now. We have environmental requirements in all of the new agreements we now sign. We have set clear requirements on what we expect in this area.”

But all responsibility is not moved over to the transporters through more stringent environmental requirements in the procurements. ICA itself pushes the environmental issue to generate change and bring about a transition of the heavy transports.

“We push the environmental issue by ensuring that there is a vehicle supply, reviewing the prices of alternative fuels and looking over the possibilities of minimising potential extra costs that come with the purchase of new technology. We push all of these issues with vehicle suppliers, fuel suppliers, authorities and various agencies to create conditions for roll-out,” concludes Per.

The search for an environmental agenda

For some time, ICA has searched for an environmental agenda with regard to transports. An important basic prerequisite in ICA’s transports is that the delivery reliability may not be put at risk. Service in retail trade is an important element of the company’s transports.

“An important basic prerequisite in ICA’s transports is that the delivery reliability may not be put at risk. Service in retail trade is an important element of the company’s transports.”

Hence, CleanTruck presents a cost calculation of a certain selection of the technologies included in the project. The difficulty in the calculations is obtaining an equivalence between the technologies. It is not really possible to achieve in this calculation, which is why it can only be viewed as an indication of cost differences between clean trucks in the project and their conventional diesel counterparts.

It involves higher costs to own and operate a clean truck, but an expanded transport assignment can entirely even out the calculation for a clean truck in relation to a conventional diesel truck.

Customer discounts on fuel are not included in the calculation. Renewable fuel is not as subjected to competition as Swedish standard diesel (M91 B5/B7), which means that the transport company’s actual net price for renewable fuels can be considerably lower than ordinary pump price. The fuel is an important component in the cost calculation for a truck.

There is a financial advantage from reduced carbon dioxide emissions as they can generate better agreements and less risk of competition.

To achieve equivalence in the comparison, no residual value is attributed to any of the comparative truck models. The residual value for a clean truck is taken up at SEK 0 by the participating transport companies in CleanTruck.

TCO (total cost of ownership) after half of the depreciation period. Clean trucks in the CleanTruck project driven in city distribution. With air suspension and added vertically adjustable distribution box. Without ATP Classification FNA and FRC.

The test with ED95 turned out well."

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<td><strong>Fuel price/litre excluding VAT</strong></td>
<td>SEK 9,30</td>
<td>SEK 9,30</td>
</tr>
<tr>
<td><strong>TCO per 10 km</strong></td>
<td>SEK 84 700</td>
<td>SEK 76 200</td>
</tr>
</tbody>
</table>

Note.

1. 26-tonne trucks cannot be compared with 12-tonne trucks.
2. Diesel comparison 26 tonnes is Scania P series Daf B70 or Volvo model FE Daf B70 with distribution box.
3. Diesel comparison 12 tonnes is a DAF of corresponding size with distribution box.
4. Equipment level is not equivalent between the clean trucks.
5. Service costs for the 12-tonne trucks are stated mileage costs and not service agreements.
6. Cash contribution is not included since the financing differs between transport companies.
7. The fuel prices are the leading oil companies’ published pump prices excluding VAT in average numbers in 2013.
**Authorities and decision makers**

When new products are introduced on the market, it may be difficult for authorities concerned and permit issuers to find reference materials to base decisions on.

In CleanTruck, this was true for the introduction of the infrastructure for ED95 and liquified gas. The filling station for liquified gas had a strong delay. This affected the introduction of diesel trucks with liquified gas. Through CleanTruck, there are now prepared materials and experiences to use in establishments of these fuels.

It is of great importance that the infrastructure investments are made and that municipalities and the business community hasten the inevitable development towards a more renewable transport sector.

A growing population and trade entail a greater need for transports of goods into the city – and a corresponding increase in waste out from the city. Just as with public transport, it is important that society plan for this necessary distribution traffic.

Long-range thinking and well-established playing rules mean everything to achieving the objective of a fossil-free vehicle fleet. In the course of the project, the playing rules have changed considerably. One positive aspect was the introduction of the vocational competence certificate for professional drivers with compulsory economical driving. Among the more important of these kinds of projects are needed; they are important to take the first steps. But they need to be followed up and supplemented with overall incentives to bring about more energy-efficient vehicles and to increase the use of renewable energy. I think the central components of this kind of project are demonstration and procurement, especially when it concerns vehicles that go into the city.

**Håkan Johansson, National Coordinator Climate Issues, Swedish Transport Administration**

“There are national environmental targets on doing away with fossil fuels. Consequently, it’s good that a project like CleanTruck brings up examples of sustainable alternatives to get a less fossil-dependent vehicle fleet. CleanTruck is important as it points out alternatives, it points out research and it points out what is actually doable. But the buyers of transports also had a lot of power in being involved and making a change; this need to be something the customers demand in order to be done in a commercial manner. I think that those who choose to adapt, who adopt environmental thinking and try to meet the customers’ demands, are the ones who will be the long-term winners.”

**Torbjörn Heierson, Regional Manager ABC, Swedish Association of Road Transport Companies**

A few comments

“A great deal has been done in terms of incentives on the car side, but they are almost non-existent on the heavy vehicle side. So these kinds of projects are needed; they are important to take the first steps. But they need to be followed up and supplemented with overall incentives to bring about more energy-efficient vehicles and to increase the use of renewable energy. I think the central components of this kind of project are demonstration and procurement, especially when it concerns vehicles that go into the city.”

**CleanTruck is important since it points out alternatives.”**

“I want to have a cleaner Stockholm and I think that we are on the right track.”

**Johannes Winberg, Sales Director, DAF**

**Vehicle manufacturers**

The vehicle technologies in CleanTruck were new on the market and were introduced in small volumes. The cooperation between the project actors, the truck manufacturers and also the dealer networks are of great importance for a successful change to clean trucks.

In CleanTruck, the relationship to the truck manufacturers and their general agent has been very good. The contact with the manufacturer’s dealer network has been more difficult but yet equally important in terms of the introduction of clean trucks since the dealer networks are closest to the end users of trucks. The project experience is that selling new, more unknown vehicles requires incentives, courage and a motivated organisation. The drivers are another crucial target group for success. Obtaining information, both during and around the driving, concerning the function of the vehicle, fuel consumption and driver behaviour, are important in order to be positive to the new vehicle. In the clean trucks for methane diesel and the hybrid electric, the support systems were not adapted to the different fuel types and drivetrains, and therefore have not been able to be fully used. It is hence likely that there is unutilised potential for further efficiency enhancements, and also knowledge about the vehicles while in use.

Some quotes

“Many distributors have a hard time today and therefore don’t dare to take risks. So the grants have been perfect to provide the courage to try new technology, because if someone begins, others follow. The smaller companies must first know that the technology works without flaws before they take the step. Both the vehicle and fuel producers need to know what will happen in the future to be able to invest time and money in new engines and filling station infrastructure. The playing field needs to be set for the next few years. Without it, we don’t know what we should invest in.”

**Johan Améen, Business Manager Alternative Fuels, Scania**

“CleanTruck is an important project where the City of Stockholm is helping out in the development by making it possible for the distributors to buy clean trucks. It is important to prioritise the companies who want to be on the forefront to safeguard the environment. So when the project got started, we immediately felt that we wanted to be involved since we had worked with clean trucks for a long time. But we also think that it’s important in projects of this type to focus on the overall emissions from the vehicles instead of focusing on certain technologies.”

**Håkan Blomén, Regional Manager Trucks, Mercedes-Benz**

“I want to have a cleaner Stockholm and I think that we are on the right track with CleanTruck, but we need continuity in the work. This was a good starting shot, but similar projects need to be continued for us to able to make a proper transition. We also have to get better at following the system of rules we have. The rules are in place, but we are currently bad at following them up.”

**Fredrik Ohlsson, Product and Logistics Manager, Volvo Trucks Nordic Region**
Infrastructure

Access to renewable fuels for heavy traffic is still limited, both in terms of under-developed infrastructure and production capacity. In recent years, the tax issue has also had a negative impact on infrastructure investments and has thereby inhibited development.

CleanTrack has contributed to a public fuel station for ED95 and a filling station for liquid and compressed gas adapted for heavy traffic. Unfortunately, this is not enough. More facilities must be built to handle supply to the transport companies that want to invest in clean trucks and in the future make Stockholm fossil-fuel-free.

To increase the proportion of renewable fuels, the availability of filling stations that provide this kind of fuel is important.

Some quotes

“We have an overall vision to be an active part of society, we want to drive development towards a more sustainable transport system. More than 39 per cent of our total climate impact is a consequence of the fuels we sell and we therefore have an important duty to help our customers make more sustainable choices in terms of fuel. This is why CleanTrack is an excellent opportunity for us. Cooperating with customers and other stakeholders, we can together test our way forward, evaluate and see what alternatives work.”

Erik Stenström Moglia, Product Manager Fuel, OKQ8

“We believe that biogas is currently the best renewable fuel and that it is one of several fuels that already reduce Sweden’s and Europe’s fossil dependence. Biogas that is produced from waste where the energy is picked out in the form of a renewable vehicle fuel and the nutrients are returned to forestry and agriculture as biofertilizer is something positive. We also consider the fact that biogas does not contribute to emissions of particulates in the city as a very big advantage compared with other fuels. The Clean Energy business area also works with renewable carbon dioxide as a coolant and nitrogen in tyres. This is products that AGA is investing in and believes in to be able to achieve a more sustainable city.”

Ragnar Sjödahl, Market Manager Biogas, AGA

“Green driving: A component of sustainable transports

A driver’s driving style also has a major impact on the truck’s consumption. Within CleanTrack, the benefit of green driving has been pointed out by the project assisting with expense compensation for continued training in green driving in addition to the vocational competence certificate, or for the use of support systems for a more green driving style.

Many positive effects

One of the most important effects of green driving is reduced fuel consumption. Climate emissions are reduced and there is money to be saved since less fuel is consumed. In addition, emissions of other harmful substances are reduced, noise levels are lowered and the working environment is becoming less stressful.

Green driving with clean trucks

Green driving with some clean trucks differs from conventional diesel trucks. Primarily the green driving differs for methane diesel and hybrid electric trucks since they are each driven by two kinds of energy making it largely a matter of using the right energy at the right time.

Support system for green driving

The challenge is achieving a long-term change in driver behaviour, both in terms of adapting to the new technology and a more efficient driving style in general. With the help of support systems in the vehicle, which actively provide the driver with direct feedback on driving behaviour, the possibilities of obtaining long-term change improve. The support systems also make it possible for the company to gather information on consumption and driver behaviour, where follow-up and communication on driving behaviour become a part of the driver’s motivation to do a good job.

Driving green with ethanol ED95

The technique for driving green with an ethanol ED95 truck does not differ from a conventional diesel truck.

Driving green with hybrid electric

A hybrid electric truck does best running on electricity - not just from an environmental and noise perspective, but also from a cost perspective since electricity is cheaper than diesel and the hybridisation itself is a major added cost. The proportion of electricity becomes highest in drives with a lot of braking and few stops. But the vehicle has to drive a little faster sometimes in order for charging the batteries. For the driver, there is a possibility to some extent controlling this through a control for boost charging. This however increases the diesel consumption.

Driving green with methane diesel

A methane diesel truck is well suited to regional traffic with few stops and low speed, as the vehicle runs on only diesel at low speeds. A well-planned route with an even speed can sometimes show lower diesel consumption and a higher share of gas, in spite of a somewhat longer drive.
**Transport cooling**

For clean trucks, it is also important to find climate-smart refrigeration units. One alternative is called Liquid Carbon Dioxide (LIC). Liquid carbon dioxide is regular carbon dioxide (CO₂) cooled to minus 65°C. The LIC units use cooled CO₂ that distributes the cold in the truck box via heat exchangers. Once the carbon dioxide has converted to a gaseous form, it is released from the truck.

The carbon dioxide is extracted as a waste by-product in various industrial processes. Through its re-use as a coolant, the carbon dioxide can work an extra time before being released into the atmosphere. In environmental terms, LIC has major benefits: the climate impact is approximately 30 per cent lower than for a diesel unit. As there is no need for idling or any engine, the unit is very quiet and has no particle emissions at all.

LIC in CleanTruck
Within the scope of CleanTruck, a total of five trucks have installed LIC units.

The technology is not new - the first LIC units for refrigerated transports in trucks were introduced as early as the 1990s. With LIC as a coolant, the cooling capacity is higher, the cooling chain is more exact and the unit is quieter than traditional diesel-powered refrigerating units.

**Nitrogen gas in tyres**

Thanks to the different structure of the nitrogen gas molecule, it does not leak out as fast as regular air. This means that the tyre pressure is retained for a substantially longer time. With the right pressure in the tyres, the truck runs more easily, it has better road holding and it uses less fuel.

Nitrogen gas in CleanTruck
Within the scope of CleanTruck, four tyre service stations at Dickis were equipped with equipment to fill tyres with nitrogen gas. The equipment is in Farsta, Spånga, Älvsås and Vallentuna.

Isn’t nitrogen gas bad for the environment? Nitrogen gas (N₂; nitrogen) should not be confused with the nitrogen used in agriculture that contributes to a negative environmental impact. The kind of nitrogen gas the tyres are filled with is completely harmless to the environment.

**Experiences from CleanTruck**

Nitrogen gas
- More constant tyre pressure
- Slower loss of pressure
- Improved road traction
- Longer service life for the tyres
- Better fuel efficiency

Keep in mind
Nitrogen gas does not replace regular maintenance. The tyre’s maximal service life is only achieved if the vehicle and the tyres are maintained in the right way. This means regularly checking tyre pressure, wheel balance and wheel alignment. When the tyres have been filled with nitrogen gas, it is important to only use nitrogen gas for refilling. If refilled with regular compressed air, the benefits of the nitrogen gas are lost.

**Supply**
The liquid carbon dioxide is filled in a special “thermotank” on the truck. In Stockholm, two pilot filling stations have been in operation for several years. Through CleanTruck, another two filling stations have been able to be built - in Kungsåra and in Järna. Outside the Stockholm region, there are another eight filling stations for the coolant. There is now enough infrastructure to guarantee service to a large number of users.

**Results and conclusions**

CleanTruck had the objective of reducing harmful emissions with:
- 3,345 tonnes of carbon dioxide equivalents
- 17 tonnes of nitrogen oxides
- 940 kg particulates (PM 2.5 and smaller)

The project has met the objectives: in the period 2010–2014 carbon dioxide emissions were reduced by 3,400 tonnes of CO₂-equivalents through CleanTruck.

Nitrogen oxides and particulates could however not be calculated since special measurements were not within the scope of the project. However, all trucks in CleanTruck meet the requirements for Euro V, and ED95 trucks and hybrid electric trucks also meet the requirements for EEE, which sets somewhat stricter requirements for nitrogen oxides and particulates. Hybrid electric trucks and the quiet liquid carbon dioxide (LIC) aggregates also helped reduce noise in the city.

CleanTruck is concluded in a situation where the project to some extent is back to square one. The next emission class, Euro VI, became a requirement at the end of 2013 and today, none of the vehicle technologies included in the project can be ordered (even if the truck manufacturers believe that several of the technologies will re-emerge). The future for renewable fuels is also very uncertain. Required quotas, taxes and uncertainty about sustainability requirements and other regulations have put a major damper on investments in both fuel production and infrastructure for renewable fuels.

The ethanol trucks in the CleanTruck project have worked very well and are the ones with the highest carbon dioxide savings. Still, there is a strong scepticism in Sweden towards ethanol for both light and heavy trucks, despite extensive work on traceability, sustainability and despite a high degree of climate benefit including low emission levels.

The entry of hybrid electric trucks into the market is interesting from many perspectives. The vehicles are expensive and the project established that the carbon dioxide reduction might not be at the top, but the vehicles have other qualities. In a city environment and for night traffic, low noise is a requirement. Hybridisation is now growing also for truck equipment, which further reduce the noise, local emissions and emissions of carbon dioxide.

Vehicle gas is a good fuel with high sustainability performance. In the project, the methane diesel trucks had a varying carbon dioxide reduction (0–41 per cent due to driving cycle). The results show that this kind of vehicle is best suited to regional transport assignments from an environmental perspective. At the same time, advancements have been made for other renewable fuels. There are several models of Euro VI approved for 100 per cent biodiesel (FAME/RME). The renewable low mixture in Swedish standard diesel (MK1 B5/7) of Fatty Acid Methyl Esters (FAME) and Hydrotreated Vegetable Oil (HVO) has increased substantially compared with the situation in the beginning of the project. Even 100 per cent renewable HVO-diesel is now in commercial operation. An important point is that conventional diesel trucks that are used, minimising the added expense and reducing the thresholds for distributors.

With CleanTruck, the City of Stockholm has taken an important step forward in terms of clean trucks. Among other things, the City has decided on a definition for clean trucks together with the City of Gothenburg. The City of Stockholm has also set the goal that 100 per cent of its own vehicles will be fossil free, 55 per cent of procured transport services will be fossil free and 10 per cent of new truck sales in the county will be clean trucks.

CleanTruck is an important step on the way to show the possibilities for more sustainable, fossil-free goods transports in the city environment. There is a need for continued work in the footsteps of CleanTruck with financial support and shared technical evaluation.
Towards the future with Clean trucks. CleanTruck has made it easy to make the right choice.”