

## 2. Why DEFA WarmUp ?

### 2.1 General

DEFA WarmUp warms the car and makes it easy to start, just as if it had already been driven a few miles. In a convenient, safe and efficient way, DEFA WarmUp ensures that warm, happy drivers are also safe and environmentally friendly – two important factors that have helped make us world leader on the market.

DEFA WarmUp is a simple, user-friendly system, operated by a control unit. By pressing a few buttons, the driver can make sure the car is easy to start, the temperature inside is comfortable and that the battery is always fully charged throughout the winter.

Environmentally friendly cars are becoming increasingly important to manufacturers and environment-conscious car owners, at the same time as legislation authorities, such as EU, constantly introduces more strict directives for maximum allowed emission from the combustion engine. Regardless of the quality of an engine, if it is cold, it will produce higher exhaust emissions and consume more fuel. Only a pre-heated engine can heat up the catalytic converter and reduce emissions to any significant degree. A pre-heated engine also uses far less fuel, is easier to start and is less subject to wear.

### 2.2 Environment

It is mainly three gases / groups of gases that constitutes the emission from a combustion engine that harms the local environment. It is hydrocarbons (HC), carbonmonoxid (CO) and nitrogendioxid (NOx). In addition to this, diesel engines dumps fine and ultrafine particles which is especially harmful.

**CO** - Toxic, colourless and odourless, may lead to heart failure. Is present in large amounts and elderly people and children stands less than other age groups.

**HC** - Cancer provocative, harmful to genes- and reproduction.

**NOx** - Toxic, leads to breathing problems, reduced lung function and resistance against bronchia infection. May damage the ozone layer.

**Particles from diesel** - Harmful to people with heart- and lounge diseases, may lead to allergic diseases.

The emissions from road traffic continued to increase also in the year 2002. This is caused by more traffic, especially diesel engines. Preliminary statistics from Transporteconomic Institute in Norway shows that in the year 2002 there were an increase of 2 % in the number of driven kilometres on Norwegian roads. The sale of petrol driven cars decreased slightly in the year 2002 (0,7%), while the sale of diesel driven engines increased with 2%. Diesel exhaust is more harmful than petrol exhaust, diesel engines exhausts ten times as much particles as a petrol engine.

#### How the catalyser works

The engines exhaust gases heat the catalyser. Before it reaches its working temperature the cleansing effect is insufficient. Depending on the outside temperature it may take several kilometres of driving before the catalyser starts to operate efficiently. In order to improve the combustion of the engine the fuel mixture is richer during a cold start. This contributes to increased emission of CO and HC. If the engine is pre-heated the damaging emissions are significantly reduced. Depending on the number of cold starts the average motorist can reduce his part of damaging emissions by 60-80% during the first 4 kilometres of driving. New research shows that the first kilometres after a cold start in a normal winter, is responsible for 90% of all emission of CO and HC from vehicle engines. Pre-heating the engine during the cold season therefore offers large environmental benefits.

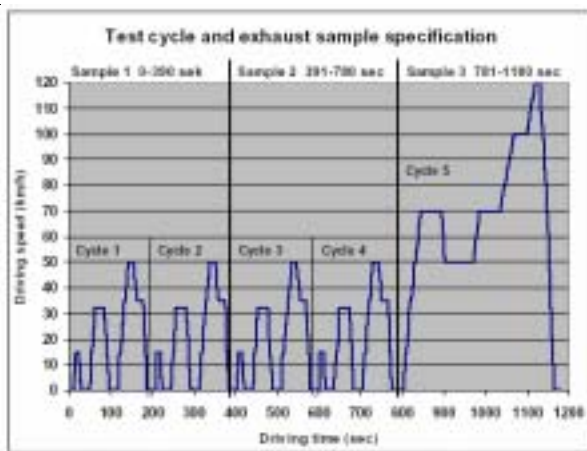
DEFA has during autumn 2003 made extensive tests regarding emissions and fuel consumption at a test laboratory in Finland. In the following you will find a short summery of the results:

## Cold start test with and without engine heater

Waste-gas emissions and fuel consumption was measured on petrol and diesel engines by cold start with or without engine heater. The measurements were made in climate chamber by -20°C at the Test Centre Tiililä Oy in Finland. 13 test cars were frozen down to -20°C and two tests were conducted - with or without using engine heater. Before the cold start test with engine heater the engine heater were turned on 3 hours before testing. Both diesel and petrol engines were tested this way.

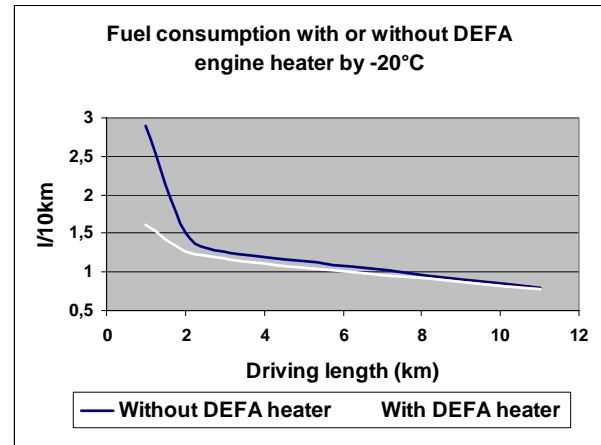
Waste-gas emissions and fuel consumption were measured by driving using a chassis dynamo which simulates city driving in 4 equal sequences which were run sequential ( 4 cycles x approx. 1km) and highway driving (4 cycles x approx.7km) according to the

EU directive 70/220/EEC and 98/69/EC (EURO 3 driving program, shown in the diagram below). Waste-gas and fuel consumption were measured continuously throughout the test. after each of the 5 sequences driven.



The tests of the petrol engines showed considerably reduction in the emission of CO and HC when using engine heater (50-80%) on the first driven kilometres. The effect on NOx and CO2 emission is on the other hand limited. The petrol consumption in average was reduced by 15-30% the first kilometre when using an engine heater. The reduction for diesel engines of emissions from CO and HC on the first driven kilometres were approx. 40-50% when using an engine heater. In addition to this the emission from CO2 was reduced by 8-12%, NOx by 12-18% and PM by 15-35%. The diesel consumption was reduced by 8-12%. The larg-

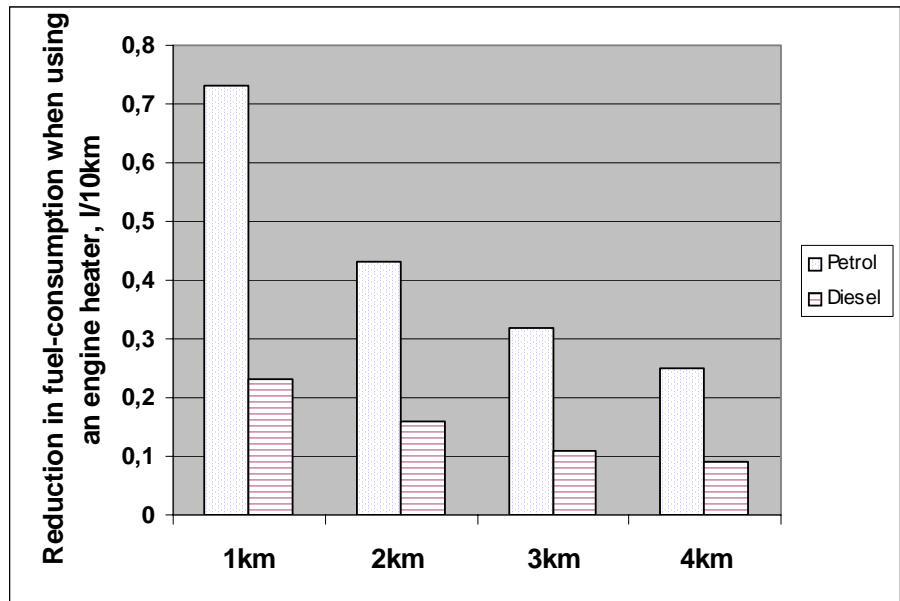
est reduction in emissions and consumption of fuel is taking place on the first driven kilometres. It is also observed some variation in the measured values, which is a result of the tests performed on different vehicles and with different engine sizes and types of engine heaters.



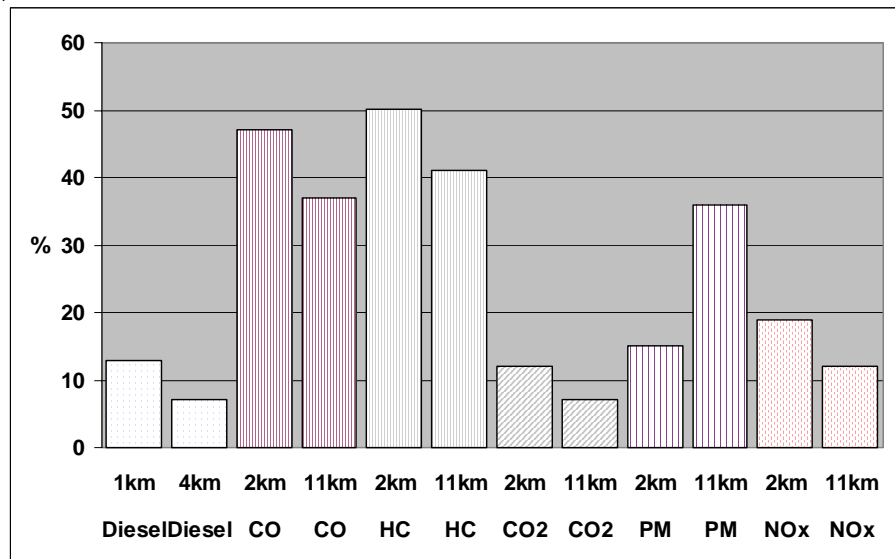
These tests have in common that all the tested vehicles using all types of DEFAs different engine heater types shows a considerable improvement during cold starts when using an engine heater.

When we look at a summary of these test it shows that the reduction is largest in the CO and HC-emissions by using an engine heater on both petrol and diesel vehicles. The CO2 emission on the other hand is less affected on petrol vehicles. On diesel vehicles the engine heater had relatively large impact on the reduction of the emissions of NOx and particles(PM).

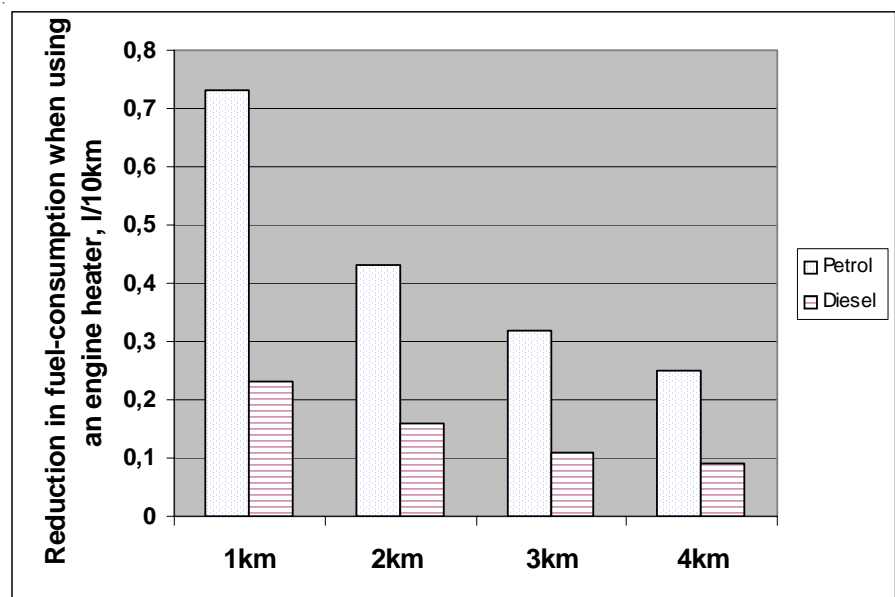
Average reduction of fuel-consumption (l/10km) by cold start at -20°C when using an engine heater (estimated per. driven distance).



Average reduction of fuel-consumption and emissions of CO, CO<sub>2</sub> and HC when using a DEFA engine heater by -20°C on petrol engines.



Average reduction of fuel consumption and emissions of CO, CO<sub>2</sub>, HC, NO<sub>x</sub>, and PM (particles) when using DEFA engine heater by -20°C on diesel engines.



## 2.3 Economy

The consumption of electricity is greatly reduced when using a temperature controlled switch-on. The system is constructed to make a relatively quick pre-heating of the engine and the interior.

This makes it uneconomic to leave DEFA Warm Up turned on more than necessary, when you after 3 hours achieves thermal balance. The power supplied after that only contributes to maintain the temperature. Excess heat will only dissipate to the environment.

The control unit in DEFA WarmUp ensures that the car is warm at desired time, using as little electricity as possible. By letting the external temperature control the switch-on of the system (Automatic), you get the absolute most cost-effective use, since the system is in operation only for the necessary time. The higher outside temperature, the shorter operation time.

## 2.4 Safety

Getting into a cold car with windows covered in ice, is not a good way to start the day. Even if the windows are cleaned from the outside, humidity and condensation will soon see to it that ice and mist are formed on the inside. Every now and then this causes serious accidents, when visibility is reduced to a minimum. The use of a DEFA Warm Up puts an end to ice scraping and icing.

### **Fully charged battery, secure start and extended battery life.**

The starting power available from a car battery is greatly reduced in cold weather (at -18° C only 40% of the original starting power is available). The car recovery companies have their hands full during the winter season with calls to help motorists with starting problems. While modern cars have better and more reliable power supply systems, the power demands have also increased thanks to such extra electrical equipment as heated windows, electric window lifts, central locking, mobile telephones, radio/tape/CD systems.

DEFA Warm Up will ensure that the battery is fully charged at all times and will contribute significantly to an extended battery life. This also contributes to a reduction in environmental pollution as the battery lasts longer.

## 2.5 Comfort

Snow, ice, hoarfrost and mist disappear, the interior temperature is raised to a comfortable level and you spare your health the exposure to a cold and unpleasant car. The engine reaches its working temperature quicker and the cars own heating system supplies warm air earlier. Forget about ice scraping and fines for poor visibility.

A cold driver is not a good driver. A driver who is cold is mentally occupied by the feeling of discomfort and is thus less able to concentrate on driving. Tests have shown that we are more liable to develop a stiff neck or a bad back if we start the day in a freezing car. The muscles tend to tighten and the flexibility of the vertebrae is reduced.