

## **A Introduction**

Skånemejerier is the primary dairy products supplier in Malmö and the rest of Skåne. Skånemejerier's environmental planning and policy includes the reduction of environmental impacts from the transport of milk from farms to the dairies and dairy products from dairies to stores. Reductions in the environmental impact of transport can be achieved primarily in the following ways: change to newer vehicles with better fuel efficiency, change to vehicles using a cleaner source of energy, train drivers in eco-driving, maintain and tune vehicles to keep emissions low and fuel efficiency high, and logistics i.e. change the driving routes to reduce the number of kilometres driven with the same amount of delivered merchandise. This measure, 5.3, concerns the introduction of newer heavy vehicles using natural gas, and preferably biogas, as the fuel source and the training of drivers in fuel efficient, environmentally-friendly driving skills and habits.

### **A1 Objectives**

The objectives for this measure are to reduce fuel consumption and the emissions of CO<sub>2</sub>, NO<sub>x</sub> and small particulates. The exact goals for each objective are quantified in the detailed measure plan or DMP for this measure. The goal of the evaluation is to be able to accurately measure the fulfilment of the objectives following the GUARD methodology.

Skånemejerier has not identified awareness of this measure as an objective within SMILE.

The measure objectives are:

- **Objective 1:** reduce fuel consumption by 10% between 2005 – 2008.
- **Objective 2:** Reduce global warming and local environmental impact as follows:
  - CO<sub>2</sub>– emissions by 62%
  - NO<sub>x</sub> – emissions by 69%
  - Small particulate emissions by 79%. Base year 2004
- **Objective 3:** to train 16 drivers in heavy vehicle eco-driving
- **Objective 4:** to replace 10 Malmö-based heavy diesel vehicles with heavy natural gas vehicles between 2005 and 2008.

The objectives for the project period 2007 - 2008 are calculated on half the gas being natural gas and half being biogas. In 2008 the improvement becomes 100% regarding CO<sub>2</sub> emissions, if biogas is the only fuel used. This depends on the success of the implementation of measure 5.2 which has involved the provision of biogas onto the natural gas grid to increase access to gas from renewable sources. Measure 5.2, while ultimately successful in reaching its objectives, has suffered delays in relation to the original timetable. However, improvements regarding NO<sub>x</sub> emissions and small particulate emissions become a few percentage units lower.

NOTE: that fulfilment of objectives 3 and 4 are a precondition for and a means to reach objectives 1 and 2.

## A2 Description

Skånemejerier aimed to replace 10 Malmö-based diesel vehicles with natural gas vehicles between 2005 and 2008. This activity was carried out with the aim to achieve the lowest possible environmental impact from the farm to the customer. The replaced vehicles were part of the fleet that delivers dairy products from dairy to stores or larger commercial buyers.

Eco-driving is a way of reducing fuel consumption by 10-15% by learning a more efficient, adaptive and safe way of driving. Eco-driving requires no investment in equipment, since practically all new cars include technology that allows for eco-driving. In this measure eco-driving for heavy vehicles was taught to 16 drivers during the first year of SMILE. Repetitive training each year was not realized despite the original stated goal of yearly refresher courses.

## B Measure implementation

### B1 Innovative aspects

The innovative aspects of the measure were:

- **Use of new technology, regionally** – There are no companies in the Malmö region that made investments in heavy gas vehicles as large as Skånemejerier did during the SMILE project. Thus the measure was an innovative and important demonstration for companies and the public sector in the region and elsewhere in neighbouring countries in northern Europe.
- **Support of demand for a new fuel, regionally** – By accelerating a shift towards gas vehicles, this measure helps provide demand for the objectives of measure 5.2
- **Change in driver habits, initially in Scandinavia, presently perhaps in other places in Europe** – At the time that the SMILE application was authored and submitted, heavy eco-driving was still in its infancy in terms of practice in Scandinavia. Today, the autumn of 2008, heavy eco-driving is no longer “innovative” in the Scandinavian context and is on the way towards becoming nearly standard procedure in a number of large road freight hauling firms in Sweden, Finland, etc. However, in a wider, pan-European context, it may very well be that heavy eco-driving can still be considered innovative.

### B2 Situation before CIVITAS

Skånemejerier has worked with ISO 9001, ISO 14001 and standards for the work environment in parallel for a number of years. Skånemejerier had, prior to CIVITAS, a few heavy gas vehicles in their fleet, but there were few other examples of concrete environmental and transport work prior to SMILE.

### B3 Actual implementation of the measure

The measure was implemented in accordance with the original plan. During the first half of SMILE new vehicles were procured and taken into use during the months that were indicated in the original measure description. During the second half of SMILE new vehicles were procured at an accelerated rate. Heavy eco-driving has been taught to 16 drivers of heavy vehicles.

**Task 1: Procurement of heavy vehicles running on gas and cooled with CO<sub>2</sub> (2005-2009)**  
– 2 or 3 vehicles have been procured yearly and taken into use as per the original plan. December 2005: 2 new vehicles. November 2006: 3 new vehicles. February 2008: 2 new vehicles. The remaining vehicles: March 2008.

**Task 2: Training drivers in heavy eco-driving (2005)** – This took place with groups of drivers during the last quarter of 2005 [SMILE Month 9 and 10].

## B4 Deviations from the original plan

The deviations from the original plan comprised:

- **Deviation 1 Heavy eco-driving** – Deviation description: according to A2 «In this measure eco-driving for heavy vehicles is taught to 16 drivers, with repetitive training each year to get the best result. » **In actual practice, Skånemejerier has not carried out the repetitive training each year since no repetitive training was held during 2006, there appears to have been some repetitive training during 2007 and there may be no repetitive training during 2008.**
- **Deviation 2 Fuel used in methane powered vehicles.** According to Skånemejerier's original plan, their methane powered vehicles would run initially on natural gas (as their few methane vehicles did prior to the start of SMILE), run on a 50-50 mixture of natural gas and biogas during 2006 and 2007, and then from 2008 onwards run on 100% biogas, depending on availability. In practice, Skånemejerier has been unable to meet these goals since Eon has decided to sell "fuel gas" which is an approximately 50-50 mix of natural gas and biogas and not differentiate products. Customers who want to buy only biogas can pay for this but physically fuel their vehicles with the 50-50 mix. With a greater number of customers buying only biogas, the gas actually supplied to all users will become increasingly biogas. **This deviation is not the result of changes made by Skånemejerier but rather made by Eon (5.2).** For the purposes of this evaluation we will assume that Skånemejerier's methane-powered vehicles have run on natural gas up to and including 2005 and thereafter have been running on fuel gas at a mix of 50% natural gas and 50% biogas.

## B5 Inter-relationships with other measures

The measure is related to other measures as follows:

- Measure 5.3 includes two sub-measures that are related: the procurement of vehicles and the training of drivers. The procurement sub-measure relies, in part, on measure 5.2, Biogas on the net, for its success. The eco-driving training is similar to the measure concerning eco-driving training of city employees (measure 11.2), eco driving for hospital employees (measure 11.8) and heavy eco-driving (measure 11.9). Therefore we can see that 5.3 may be contained in two clusters of measures in Malmö: "gas" and "training".

Relations among the eco-driving measures in SMILE Malmö:

In Malmö there are four measures - 5.3, 11.2, 11.8 and 11.9 - that deal solely or in part with what is called "eco-driving" which is a driver technique, approach and strategy to reduce fuel consumption without reducing driving speed. While all four measures include eco-driving, the results are not always easily compared and some of the assumptions or factors used in calculations differ between these measures. The reasons for this are as follows:

The target staff or drivers have varying degrees of incentive or motivation to continue to apply the eco-driving technique in the weeks, months and years following their training. The primary incentive comes from a reward, often in the form of financial gains – directly or indirectly – corresponding to the costs of saved fuel that has resulted from eco-driving.

The target staff or drivers have different relations to the vehicles and their work situation. Some of the drivers in some of the measures are professional drivers: that means driving is their occupation. Such drivers may have regular routes that they take where they may be able to perfect their efforts to reduce fuel. Others drive vehicles rather regularly as part of their work, but this is not the primary part of their occupation or profession. Still other driver may irregularly and for shorter distances use vehicles as part of their work. This means that the

results of the eco-driving measure will vary because of the frequency of driving and at the relative centrality of driving as part of the employees' occupation.

Some drivers almost always drive the same vehicle. Infrequent drivers are more likely to drive a different make of vehicle almost every time they need to use a vehicle.

Finally, there are different kinds of vehicles that are used by drivers in the four measures and the reasons for driving vary.

In comparison we can say:

### 5.3

That the drivers of heavy vehicles in 5.3 are employees of freight haulers and these employees may not be receiving a financial incentive. The supplier of the training, Skånemejerier, is not the employer. There are indications that the effects of eco-driving fell from about 13% to about 3% reduced fuel use when there was no refresher training but this may have then improved when refresher training was introduced much later in the measure.

### 11.2

For the municipal employees in 11.2 the initial reduction of fuel was about 13% but since the employees have no incentive to continue to drive this way (fuel savings do not accrue to them, they are not awarded in some other way), this savings tends to have approached nil within a year and we assume that it is zero after one year. There is no refresher training. Most managers or section heads do not see the relation between training staff in eco-driving and financial performance of their section.

There are some exceptions within 11.2 among individual drivers and managers who can see the benefit from eco-driving for their section's financial performance but these are truly the exception.

### 11.8

In the hospital, it proved difficult initially to get any medical or care staff to take the training. As a result we only have statistics from the regular transportation staff in the hospital. There may be some measure of incentive for the transportation staff since it is a small unit and cost savings can be more easily tracked and attributed to driver performance. For the other parts of the hospital where staff took the training fuel costs are often small in comparison with the total budget and it is hard for either the managers or staff to see the advantage: again there is no incentive.

### 11.9

This last measure, like 5.3, only involves heavy vehicles. However, unlike 5.3, most people who took the training were owner-operators of their own vehicles and as such have a financial incentive to maintain a high degree of eco-driving performance. From an initial savings of about 17% in terms of fuel consumption this falls to 10% or less in the longer-term. However, fuel savings accrue to the individual driver or, in some cases, the small firms that have joined the umbrella organisation Malmö LBC.

Thus we see that even if all measures attempt to reduce fuel consumption using the same basic techniques and methods, the context within which the measure is rolled-out has a clear impact on the long-term effects. More motivated drivers with a form of incentive tend to have driving habits similar to the ideal in eco-driving than drivers who have no form of incentive at all. Motivated drivers retain the positive effects of eco-driving.

This lengthy passage appears verbatim in the B5 section of 5.3, 11.2, 11.8 and 11.9 to make it easier for readers who might want to compare these measures.

## C Evaluation – methodology and results

### C1 Measurement methodology

The formulation of the objectives in the technical annex does not always specify how the reductions of emissions are quantified and measured: ie are the reductions in emissions measured as a % of all heavy vehicle emissions or as a % of emissions of the heavy vehicles that are replaced? Emission reductions can be achieved through greater fuel efficiency after drivers have had eco-driving training and/or replacement of diesel vehicles with methane powered vehicles. **The original measure description (from 2005) for 5.3 relates the objectives for emissions to the retirement of vehicles and relates the objectives of reduced fuel consumption to training in eco-driving.** The original measure description appears to suggest that the % reductions of emissions is only related to the replacement of the original vehicles and has no relationship to the remaining vehicles in Skånemejerier's fleet of heavy vehicles. However in C2.3 we have also taken the whole fleet at three time periods: baseline, year 1 and year 4 as the basis of calculations as well as calculations for only the vehicles directly replaced or procured.

#### ASSUMPTIONS:

It is assumed, based on information provided by representatives of Skånemejerier, that each vehicle that was replaced during SMILE was driven approximately 20 000 km per year and that the replacement vehicle was driven the same distance on a yearly basis. In the calculations the number used is 21 600 km per year based on suggestions given by the company's environmental consultant about the actual distance driven.

Further: the price of fuel gas throughout SMILE has been rather constant. According to Skånemejerier during mid-spring 2007 it was 6.4 SEK/m<sup>3</sup> fuel gas (50% natural gas/50% biogas) which is 8.7 SEK/litre if you calculate a fictive equivalent value to more readily make comparisons with diesel. Since the price of fuel gas has remained quite stable (for example March 06-August 07 no price change at all according to EON) we retain this value in all calculations in this report.

#### C1.1 Impacts and Indicators

Table 1: List of Indicators for Measure 5.3

Nr.	GUARD Nr.	INDICATOR Name	DESCRIPTION	DATA /UNITS
MSE-31	1	Operating revenues, generic indicator	Revenues generated in comparison with if the measure had not been carried out	Euros/vehicle (possibly euros/ vkm)
MSE-32	2	Operating costs, generic indicator	Costs incurred in comparison with if the measure had not been carried out	Euros/vehicle (possibly euros/ vkm)
3		Vehicle fuel efficiency	Fuel used per vkm, per vehicle type	MJ/vkm , derived
MSE-28	4	% of vehicles vkm that are run on biogas	% of vehicles vkm that are run on biogas	
8		CO <sub>2</sub> emissions	CO <sub>2</sub> per vkm	G/vkm, derived
10		NO <sub>x</sub> emissions	NO <sub>x</sub> per vkm	G/vkm, derived
11		Small particulate emissions	PM <sub>10</sub> per vkm	G/vkm, derived
13		Awareness level	Degree to which the general publics awareness has changed	Qualitative

In the original DMP, Skånemejerier did not identify awareness of this measure as an objective within SMILE. However, later they have come to see this as valuable for inclusion in the indicator table. *This means that the indicator has no connection with measure objectives.* Additional items included in the original table of indicators but not mentioned in the objectives section of the DMP include vehicle-km and vehicle speeds during peak and off-

peak hours, the number of vehicles moving in demonstration areas (assumed to be the environmental zone being established by the City of Malmö in measure 6.1), and the operating revenues and costs for this measure. This lack of consistency has led to the removal of indicators not deemed to be associated with objectives with the exception of “awareness” that Skånemejerier was very keen to have included.

Detailed description of the indicator methodologies:

- **Indicator MSE-31** (*Operating revenues, generic indicator as opposed to operating revenues indicator used for PT only GUARD nr 1*) – According to Skånemejerier, there are no revenues for this measure. However, “reduced costs” from lower fuel consumption and lower costs for fuelling with natural gas/biogas can be considered as a form of “revenue”. This indicator has been calculated based on “reduced costs”.
- **Indicator MSE-32** (*Operating costs, generic indicator as opposed to operating costs indicator used for PT only GUARD nr 2*) – This indicator has been calculated but should not be considered definitive pending possible methodological considerations in relation to the CEA Evaluator Tool.
- **Indicator 3** (Vehicle fuel efficiency) – Since the DMP suggests that improvements in fuel consumption are related to training in eco-driving, the results of this training are used to complete this indicator.
- **Indicator 8** (CO<sub>2</sub> emissions) – Since the DMP suggests that changes in emissions are related to vehicle procurement and retirement, the results of eco-driving are kept separate from this indicator.
- **Indicator 10** (NO<sub>x</sub> emissions) – Since the DMP suggests that changes in emissions are related to vehicle procurement and retirement, the results of eco-driving are kept separate from this indicator.
- **Indicator 11** (PM<sub>10</sub> emissions) – Since the DMP suggests that changes in emissions are related to vehicle procurement and retirement, the results of eco-driving are kept separate from this indicator.
- **Indicator 13** (Awareness level, degree to which the awareness on the part of the general public has changed) – This indicator comes from a general survey of the general public in Malmö to determine their awareness of the activities undertaken by several organisations in SMILE.
- **Indicator MSE-28** (Percentage of the replaced vehicles vkm that are run on biogas) – *Deviation 2 under B4 is taken into account when this indicator is calculated.*

## C1.2 Establishing a baseline

A baseline in the context of SMILE and the GUARD methodology is a determination of the situation prior to the starting of the SMILE or CIVITAS measure. The baseline for 5.3 is the situation before procurement of the 10 heavy vehicles that run on methane and before the eco-driving training conducted during the last quarter of 2005.

The baseline can therefore be expressed in the total amount of diesel used by certain vehicles prior to the start of SMILE. The vehicles to be included in the base line would be those that have been or will be retired within SMILE (10 vehicles) and the vehicles used by the 16 vehicle drivers that received heavy eco-driving training.

Since eco-driving and the first procurement and use of the new vehicles did not start until the latter half of 2005, we can use the first half of 2005 as the time period during which a baseline is established. Below follows a list with the following data for the 10 vehicles that were

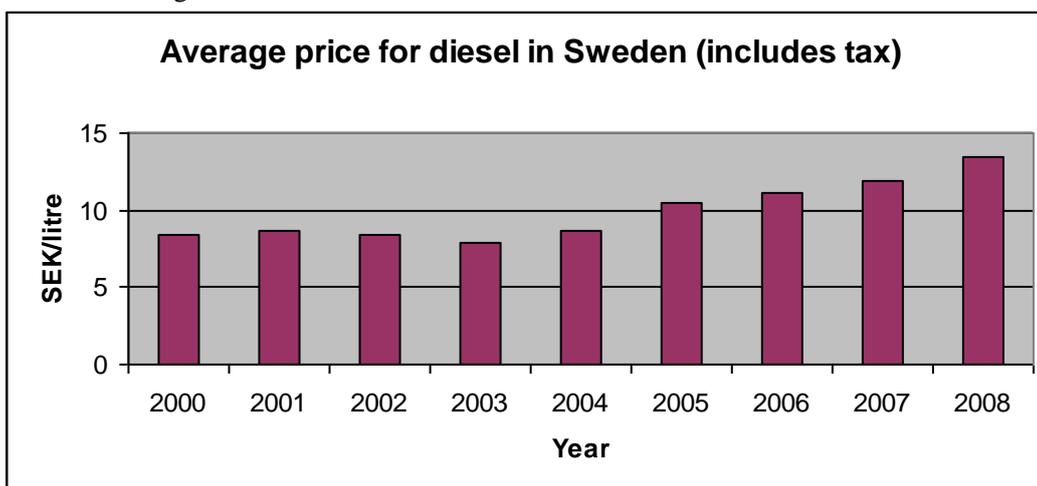
replaced: km driven, fuel used total and per km, estimated cost of diesel per litre at the time as well as fuel cost per km together with estimated emissions of CO<sub>2</sub>, NO<sub>x</sub> and PM<sub>10</sub>.

Baseline: First half of 2005

- Km driven per year by the 10 vehicles: approximately 216000 km
- Fuel used per year by the 10 vehicles: approximately 100 000 litres of diesel
- Fuel used per vkm by the 10 vehicles: 0.46 l diesel/vkm
- Cost of diesel per litre: 9.96 SEK/litre (this is the average price for the first six months of 2005)
- Cost of diesel per vkm: 21.51 SEK/vkm
- Emissions of CO<sub>2</sub> per vkm: 2.52 kg
- Emissions of NO<sub>x</sub> per vkm 11.54 g
- Emissions of PM<sub>10</sub> per vkm 0.175 g

The reader should note that the emissions in the list above differ slightly from the emissions per vkm in Table 5.3-C2.3a. This is because the baseline (B) in the Table 5.3-C2.3a is the entire fleet which at the time had 6 pre-SMILE gas powered vehicles whereas the Baseline described above on this page covers only the 10 trucks that were replaced as part of SMILE.

Figure C1: Development of diesel prices in Sweden. Yearly averages. For 2008 prices are up to and including mid-October.



**C1.3 Building the business-as-usual scenario**

The business-as-usual scenario in the context of SMILE and the GUARD methodology is a determination of what would be happening at the end of SMILE if the particular measure had not been implemented. For 5.3 the business-as-usual scenario would be very similar to the baseline. The differences between the baseline and the business-as-usual scenario would arise because of three factors. The first factor would be changes in the market and the demand for and supply of Skånemejerier dairy products which could influence the planning of delivery routes and other logistic matters. The second factor would be the replacement of older diesel-powered heavy vehicles with newer diesel-powered heavy vehicles because of pre-existing plans to retire older vehicles and replace these with similar vehicles. The third factor would be changes in the price of diesel and vehicle gas.

For the purposes of this evaluation, we will assume that whatever changes there might be for factor one would be very minor.

The natural replacement of ageing vehicles is another matter and can be more readily determined. According to Tord Fredlund of Skånemejerier, the first two heavy vehicles that were replaced as part of SMILE would otherwise have been replaced in 2008 or 2009 by other diesel vehicles. This means that SMILE has impacted on the vehicle replacement by acceleration of the date when the replacement occurred and that the new, replacement vehicles were methane (natural gas and/or biogas) powered. The remaining 8 heavy vehicles that have been or will be replaced within SMILE would have been subject to retirement first in 2010 and later.

This means that between 80-90% (8 or 9 out of 10) of the vehicles that are retired and replaced because of SMILE would not have been retired and replaced **EVEN WITH NEW DIESEL VEHICLES** in a business-as-usual scenario. This means that this part of the business-as-usual scenario is very similar to the baseline situation.

For the purposes of this evaluation, we will equate the baseline with the business-as-usual scenario with the third factor, the cost for diesel. As can be seen in figure C1, the costs for diesel have been rising on a yearly basis. For the first half of 2007, which will be the time period used for the scenario, the average price of diesel was 13.29 SEK/litre. This means that in two years the price of diesel increased by 3.33 SEK/litre.

#### Business as usual: First half of 2007

Km driven per year by the 10 vehicles: approximately 216000 km

Fuel used per year by the 10 vehicles: approximately 100 000 litres of diesel

Fuel used per vkm by the 10 vehicles: 0.46 l diesel/vkm

Cost of diesel per litre: 12 SEK/litre (This is not exactly the average price for the first six months of 2007 but was the price suggested by Skånemejerier and used in previous calculations.)

Cost of diesel per vkm: 25.92 SEK/vkm

Emissions of CO<sub>2</sub> per vkm: 2.52 kg

Emissions of NO<sub>x</sub> per vkm 11.54 g

Emissions of PM<sub>10</sub> per vkm 0.175 g

The reader should note that the emissions in the list above differ slightly from the emissions per vkm in Table 5.3-C2.3a. This is because the baseline (B) in the Table 5.3-C2.3a is the entire fleet which at the time had 6 pre-SMILE gas powered vehicles whereas the Baseline described above on this page covers only the 10 trucks that were replaced as part of SMILE. The reader should also recall from the previous page the reasons why the business as usual scenario can be equated to the baseline, with the exception of the costs for diesel fuel.

## **C2 Measure results**

The results are presented under sub-headings corresponding to the areas used for indicators – economy, energy, environment, society and transport.

- Objective 4 has been or will have been achieved by the end of 2008: 10 of 10 new vehicles will be in operation.
- Objective 3 was achieved at least in part by the end of 2005: 16 drivers received training in heavy eco-driving. However, no brush-up training or repetitive exercises were carried out during 2006. While some form of brush-up training has been offered during 2007, at present it would appear that lack of continuous training on a regularly scheduled basis will not lead to drivers always retaining the positive results from 2005.
- Objectives 1&2 rely on the success of Objectives 3 and 4 as well as the successful implementation of measure 5.2. Since Objective 3 was not met in its entirety this has had an impact on the success of Objectives 1&2.

## C2.1 Economy

For indicators MSE-31 operating revenues (related to GUARD indicator 1) and MSE-32 operating costs (related to GUARD indicator 2), the numbers reported here should be taken as preliminary.

MSE-31 is derived from reductions in operating costs for fuel. MSE-32 comes from the increased operating costs for using the new vehicles. According to Kaj Grenrud et al at Skånemejerier the reduction of fuel costs per methane vehicle was in 2007 approximately 33 000 SEK/year. This is based on a diesel price of 12 SEK /litre and a natural gas/biogas 50-50 mix (sold as fuel gas) at 6.4 SEK/m<sup>3</sup>. Obviously the reductions in operating costs for fuel will change and increase as costs for diesel increase if the fuel gas price remains relatively stable as it has done so far.

Kaj Grenrud et al at Skånemejerier state that use of the methane powered vehicles entail extra costs compared with diesel vehicles. This they place as operating, non-fuel costs at approximately 40 SEK/vehicle/day during a 10 year period (i.e. approximately the life of the vehicle during which time it is used by Skånemejerier). Representatives of Skånemejerier could not elaborate on the nature of these costs.

MSE-31 expressed as reduced fuel costs per vehicle km driven is approximately 1.57 SEK/vkm in 2007 year prices.

MSE-32 expressed as additional operating costs per vehicle km driven is approximately 0.69 SEK/vkm in 2007 year prices.

Indicator	BAU value	After value	Difference
MSE-31: fuel costs per vehicle km	25.92 SEK/vkm	24.35 SEK/vkm	-1.57 SEK/vkm =6%
MSE-32: additional operating costs per vehicle km	Not quantified separately	Not quantified separately	+0.69 SEK/vkm

Note that as of late May 2008 diesel cost approx 14.4 SEK/litre as opposed to 12 SEK/litre during the same timeframe during 2007. Diesel prices continued to rise during the summer of 2008 but fell back to just under 13 SEK/litre during September and October 2008.

## C2.2 Energy

Indicators 3 and MSE28 (which is similar to Guard 4) are the indicators used here. The eco-driving training conducted in the latter part of 2005 lead to an average decrease in fuel consumption on the part of the 16 drivers by 13% according to Börje Olofsson at Skånemejerier.

A distribution truck used by Skånemejerier primarily in Malmö is driven approximately 21 000 km per year but this is an average number. Not all of the 16 drivers who received eco-driving training drive exclusively in Malmö proper and their routes can vary from year to year. However for the purposes of this evaluation the figure 21 000 km per truck and year will be used.

Skånemejerier claims that its diesel fleet uses 10 000 litres of fuel per truck per year. After eco-driving with a 13% reduction in fuel consumption this would mean per driver and truck a reduction of 1300 litres per year or with all drivers a total of 20 800 litres of diesel per year.

This fuel reduction is based on the assumption that the drivers that took the eco-driving course continued to drive diesel vehicles. In practice drivers may drive both diesel and methane powered vehicles. However, the majority (about 75%) of Skånemejerier's heavy vehicles will still be diesel powered by the end of SMILE. Thus we assume continued driving in diesel

vehicles is the norm. The interchange between vehicles also makes it impossible to identify individual savings as a result of the ecodriving.

Since Skånemejerier has not conducted refresher training sessions for eco-driving on a yearly, regular basis, the effects of eco-driving we will assume to be so far reduced at some point after the training that no distinguishable effect could be found. Depending on the starting point drivers received training during month 9 or 10. We have chosen to establish the cut-off point as month 24 which is slightly more than one year after the training. This cut-off can be seen as arbitrary but reflects that without refresher training a number of drivers will have reverted to previous driving habits rather quickly whereas a few drivers may have a retention rate even 12 months after training. (\*)

Therefore indicator 3 is as follows:

14.5 months from training to minimal residual effect remaining is 1.12 years

1.12 years X 16 drivers X 1300 litres per year = 23 296 litres saved.

If this is then distributed among the distances driven by the 16 drivers in one year, approximately 336 000 km, this means that the eco-driving sub-measure reduced vehicle fuel consumption by 0,069 [litres](#) per km over a 14.5 month period.

\*  
According to Mats Rosenkvist, a consultant employed by Skånemejerier for some of their environmental work, he believes that the 16 drivers had ultimately a 3% reduction in fuel use thanks to heavy eco-driving but this is more of a hunch than a clear figure with hard numbers backing it up. With refresher training sessions on a yearly basis fuel savings would approach 13% again. However since such refresher sessions do not appear to be held on a regular basis the positive effects of eco-driving training are largely lost with time.

regard to the switch from a fleet with diesel powered vehicles to a greater percentage that run on biogas the indicator is the following. Prior to the start of SMILE Skånemejerier had approximately 60 heavy vehicles and of these 6 could run on methane (ran in practice on natural gas.) By the end of SMILE Skånemejerier will have a similar number of heavy vehicles and of these 16 will run on methane (run in practice on a 50-50 mixture of natural gas and biogas. This means that prior to the start of SMILE the % of vehicle km run on biogas was 0% but by the end of SMILE, month 48 (= January 2009), the percentage will have increased to approximately 13.3% (16 vehicles run on a mix) based on comparison with the entire fleet.

Indicator	BAU value	After value	Difference
3: fuel consumption change due to heavy eco driving	0.460 l/vkm	0.403 l/vkm	-0.57 l/vkm =12.4%

**C2.3 Environment**

Indicators 8, 10, 11 demonstrate the result of vehicle retirement and the switch to other fuels that will be increasingly renewable. The effects of reduced fuel consumption from eco-driving have been considered separate in the DMP from 2005 and this is presumably because the effects of the fuel change would tend to be much greater on emissions than a reduction in fuel use from eco-driving.

Another methodological concern is that the 6 methane powered vehicles used by Skånemejerier prior to the start of SMILE, while not part of 5.3 *per se*, will be using “fuel gas” during much of the duration of SMILE. In C2.2 we have included these vehicles in the calculation of indicator MSE-28. Therefore these vehicles will be included in the calculations of the indicators.

The following tables show indicators 8, 10 and 11 during key points in the development of measure.

Table 5.3-C2.3a: The Entire Fleet, replacement of vehicles

Time	Indicator 8	Indicator 10	Indicator 11	Effects of eco-driving
B: Baseline, start of 2005	2.60 kg CO <sub>2</sub> /vkm	11.11 g NO <sub>x</sub> /vkm	0,17 g PM <sub>10</sub> /vkm	Sub-measure not started
S: Start period, much of 2006	2.43 kg CO <sub>2</sub> /vkm	10.86 g NO <sub>x</sub> /vkm	0,16 g PM <sub>10</sub> /vkm	Would have started here (not included)
F: Final month, January 2009	2.25 kg CO <sub>2</sub> /vkm	9.85 g NO <sub>x</sub> /vkm	0,14 g PM <sub>10</sub> /vkm	Distinguishable effects absent

#### Explanation in tables:

B: During the first half of 2005, a baseline, with 6 methane powered vehicles running on natural gas only, the emissions of the fleet are expressed as emissions per vkm.

S: During much of 2006, during the months following the eco-driving training, emissions per vkm **may** have fallen more because of reduced fuel consumption but this is excluded from the calculations. A total of 8 methane powered vehicles running on “fuel gas” – a 50-50 mixture of natural gas and biogas – suggests the following emissions.

F: During the final month of SMILE in January 2009, a total of 16 methane vehicles all running on fuel gas suggests the following emissions.

Table 5.3-C2.3b: Emissions for the **entire fleet** of 60 vehicles are as follows:

Time	Total kg CO <sub>2</sub>	Total g NO <sub>x</sub>	Total g PM <sub>10</sub>
B:	3 276 000	13 999 230	210205
S:	3 057 600	13 681 080	204422
F:	2 839 200	12 408 480	181287

Table 5.3-C2.3c Corresponding figures for **only the 10 trucks** involved in SMILE are the following.

Time	Total kg CO <sub>2</sub>	Total g NO <sub>x</sub>	Total g PM <sub>10</sub>
B:	546 000	2 492 280	37 926
S:	491 400	2 174 130	32 142
F:	273 000	901 530	9 008

This means for the 10 trucks involved in the SMILE measure, emission reductions have been 50% for CO<sub>2</sub> 64% for NO<sub>x</sub> 76% for PM<sub>10</sub>

## C2.4 Transport

No indicators under the transport evaluation category are relevant for the objectives and tasks in this measure.

## C2.5 Society

The indicator “awareness” (i.e. Guard indicator number 13) is of interest here. A number of measures in Malmö were evaluated –at least in part-- using a questionnaire distributed during April and May 2008 among the general public. In the pilot questionnaire questions were asked about activities which several organisations in SMILE were working with as a way to judge awareness. Because of a low response rate to certain questions in the pilot questionnaire, the revised questionnaire did not include questions directly related to Skånemejerier.

607 pilot questionnaires were returned. Respondents were asked to associate Skånemejerier with one or more of the following topics/areas: Car-sharing, Biogas, Eco-driving,

Environmentally-adapted logistics, Greater number of environmental vehicles. The degree of association was as follows:

	Car-sharing	Biogas	Eco-driving	Environmentally -adapted logistics	Great number of environmental vehicles
Absolute number	5	29	27	40	33
Percentage	0.8%	4.8%	4.4%	6.6%	5.4%

The association with car-sharing can be perhaps written off as a misunderstanding concerning the nature of car-sharing. That logistics receives the highest response can be perhaps attributed to some form of general association with the nature of Skånemejerier’s business and the need for logistics. This means that there is some form of “false association” taking place here: people attribute activities to organisations that they think should be doing such things and not by actual knowledge of the situation. However, recently Skånemejerier has been working on logistics issues as part of SMILE so this could reflect real knowledge on the part of the general public IF Skånemejerier has publicized this work.

The remaining three areas show some form of awareness of the SMILE measures on the part of the general public. Here we see that about 4-6% of the public are either aware of Skånemejerier’s activities in SMILE or associate Skånemejerier with the use of biogas, eco-driving, and an increasing number of environmental vehicles. These figures suggest that the level of awareness is low on the part of the public, perhaps because of the absence of marketing by Skånemejerier.

Starting during 2008 but increasing during the year, Skånemejerier has embarked on promoting its environmental credentials with the general public. This means that polling the same respondents about Skånemejerier, transportation and the environment towards the end of 2008 might have led to a higher response rate and a greater awareness and understanding of what activities in the areas of transport and the environment Skånemejerier has been involved in.

### C3 Achievement of quantifiable targets

Table C3: Overview of objective fulfilment

No.	Target	Rating
1	Reduce fuel consumption by 10%.	<b>* (*)</b>
2	Reduction of emissions as follows: CO <sub>2</sub> by 50%, NO <sub>x</sub> by 64%, PM <sub>10</sub> by 76%	<b>**#</b>
3	To train 16 drivers in heavy vehicle eco-driving.	<b>* (*)</b>
4	The replacement of 10 Malmö-based heavy diesel powered vehicles with heavy natural gas/biogas powered vehicles	<b>**</b>
<b>NA = Not Assessed    0 = Not achieved    * = Substantially achieved (&gt; 50%)</b> <b>** = Achieved in full            *** = Exceeded</b>		

Note that the rating of **\* (\*)** refers to the short achievement with eco-driving training leading to a 13% reduction in fuel consumption and the training of 16 drivers but that the positive results could not be maintained in full because of no refresher courses/training were held during 2006 or (to our knowledge are planned for) 2008. **#** this relates to the combined impact of ecodriving and a new clean vehicle at the individual level

## C4 Up-scaling of results

There are two ways of thinking about how the results can be up-scaled. On the one hand, Skånemejerier could choose to accelerate its retirement of diesel vehicles for new methane powered vehicles. There is a certain limitation of this up-scaling since Skånemejerier has a finite number of vehicles and biogas and/or natural gas is not available in all places (outside Malmö) where Skånemejerier delivers its dairy products. A trend outside of SMILE that could encourage this upscaling is the rising price of diesel (up by 16% from Spring 2007 to Spring 2008) which is likely to continue during the long-term as world demand for fossil fuels grows (economic growth in China and elsewhere) while the price of biogas or even fuel gas with its 50% fossil content remains relatively steady. However, during the short-term (rest of 2008 and until 2009) the picture may be less clear.

On the other hand, other organisations that deliver foodstuffs and other temperature sensitive goods that have similar qualities to Skånemejerier's products could choose to accelerate the retirement of their delivery vehicles in favour of new vehicles running on methane. This up-scaling would be readily possible in and around Malmö. But in a variety of other locations in Sweden would not be as easy or possible because of the absence of filling stations or facilities with methane for vehicles. Here up-scaling relies on infrastructure decisions.

The degree of adoption of Skånemejerier's results by other organisations may largely depend on the following factors:

1. The degree to which Skånemejerier's management sees 5.3 as a positive development for the company despite this measure "only entailing costs and not producing direct revenues" as an employee expressed the situation in March 2007.
2. The degree to which the positive impression Skånemejerier's management has of 5.3 is actively communicated to competitors, business collaborators and other market actors.
3. The degree to which organisations around Skånemejerier see and understand the measure as positive and something that they should seek to copy.
4. The degree to which the necessary methane filling infrastructure (biogas/natural gas) expands in and around Malmö as well as in other places in Sweden where such infrastructure is weak or non-existent and the rest of Europe.

Here we can see a clear role for SMILE dissemination activities with regard to factors 2 and 3 above. However, because Skånemejerier has had difficulty finding revenue to offset costs in 5.3 – this revenue was found in part with money from SMILE -- it may be that it is unlikely that factor 1 will be fulfilled in the near future.

With regard to which is more likely and what effects might result: even if Skånemejerier's contracted hauling firms might want to switch to gas-powered vehicles, they still have to recover their investment costs by continuing to use some of their older vehicles. Furthermore, they probably lack capital to accelerate their retirement of diesel lorries with new gas-powered lorries. It is more likely that up-scaling will occur across a number of organisations now that Skånemejerier has a number of modern gas-powered vehicles to demonstrate successful use. In all likelihood, the effects of up-scaling would be greater if it occurs outside Skånemejerier (and the freight companies employed by Skånemejerier) since there are a greater number of potential vehicles that can be more quickly replaced. This is in part because a greater number of organisations would be making investments in new vehicles and thus "spread" the costs.

## C5 Appraisal of evaluation approach

The primary problem in the approach is that there is uncertainty when the distinguishable effects from eco-driving training actually have ended. This is however connected with the deviation from the initial plan where refresher sessions were supposed to be held on a yearly basis but have not been achieved. Had refresher sessions been held on a regularly scheduled basis it would have been necessary to follow up driver behaviour before and after each

session. Because of the “one-off” nature of the eco-driving activity in 2005 -- as perceived by the technical evaluator -- we can see that the effects will not be very long-term, as other studies of the effects of eco-driving tend to suggest.

Worth considering in this context is the value of studying the driving behaviour of 16 drivers. In the entire context of all SMILE measures in Malmö this number of drivers is very marginal in relation those hundreds of municipal employees offered eco-driving and the over 100 at Malmö LBC that have had eco-driving. This is a question of the allocation of scarce evaluation resources.

During the first half of 2007 the technical evaluator decided to base the business as usual scenario and the results of the measure on the time period “first six months of 2007”. This was because of concerns at the time that the measure might be delayed and not all vehicles might be procured before the end of SMILE and that there appeared to be no refresher training for heavy eco-driving planned. By choosing the beginning of 2007, when five vehicles had been procured and taken into operation, it was also possible to estimate a “doubling” of the five vehicles into the ten vehicles in total that were supposed to be purchased by the end of SMILE.

Sometimes the effects were determined without input from Skånemejerier and their consultant at a time after meetings. Effort was placed on getting to the effects – the difference between the scenario and the measure – and not 100% detailed documentation of the basis of the input figures for the baseline and the business as usual scenarios.

Because of this much effort has been spent during the latter half of 2008 to recreate and provide numbers in parts of the baseline and business as usual scenario. However, this has not always been possible for all figures. In part this is because of managerial and staff reorganization at Skånemejerier leading to some key people no longer working at Skånemejerier and, hence, some underlying statistics are no longer readily available.

For this reason, the difference between the results of the measure and the business as usual scenario may not be EXACTLY those presented in the various parts of C2. This is because of some discrepancies in the underlying data used during 2007 and early 2008 versus attempts to collect similar underlying data now during the latter half of 2008.

## C6 Summary of evaluation results

The key results are as follows:

- **Key result 1** – Eco-driving was successful but up until at least March 2007 was not considered by Skånemejerier as sufficiently important or profitable to continue with refresher or brush-up sessions and/or onboard supporting equipment that helps drivers keep track of their fuel consumption. This despite eco-driving being a very profitable and not capital-intensive activity. This means that the positive results from 2005 – a reduction in fuel use of about 13% -- have been difficult to maintain over a 2-year period.
- **Key result 2** – Procurement of methane-powered heavy vehicles has made the following **impact on the total level of emissions** from Skånemejerier: For the entire fleet (60 vehicles covering 12960000 km in one year) a reduction of 436.8 tons of CO<sub>2</sub>, 1.6 tons of NO<sub>x</sub>, 29 kg PM<sub>10</sub>, equivalent to 13.3%, 11.4% and 13.8% respectively.

Use of these vehicles has contributed to the demand for biogas which supports measure 5.2.

For the 10 trucks involved in the SMILE measure the emission reductions have been

50% for CO<sub>2</sub> 64% for NO<sub>x</sub> 76% for PM<sub>10</sub>

for the 216000 km covered in one year

- **Key result 3** – Continuation of these measures within Skånemejerier probably will depend on the development of the following:
  - a. the degree to which the management of Skånemejerier perceives profitability in these measures and the importance of these measures to reduce emissions and fuel consumption as part of Skånemejeriers environmental profiled
  - b. the degree to which increasing divergence between costs for diesel and cost for biogas continues
  - c. the possibility for the fall in price for methane powered vehicles of the kind that Skånemejerier has purchased and uses for deliveries in and around Malmö
  - d. the expansion of fueling stations for fuel gas both in terms of greater density in the areas of Sweden where Skånemejerier has its principle business as well as elsewhere in Sweden

## D Lessons learned

### D1 Barriers and drivers

#### D1.1 Barriers

- **Barrier 1** – Changes to the way that biogas is being marketed for road transport have meant that instead of being able to access 100% biogas most users are now only able to physically access 50% biogas.
- **Barrier 2** – Investments in clean vehicles and driver training require significant financial investment, in this case on the part of a private sector dairy / distribution company. Justification of such investment requires some form of return either in terms of direct financial benefit to the company through cost savings / increased income or indirect benefits such as improved company image with consumers and business customers. Within this measure this resulted in a staged implementation of the new vehicles in order to minimise cash flow issues and also meant that refresher courses for the driver training element that were originally planned did not take place.
- **Barrier 3** – The involvement of the private sector company has been helped in this case by funding from the European Commission through CIVITAS SMILE. However, even in this case the proportion of the investment received was apparently considered by the private sector company to be too small when environmental benefits will be incurred by the wider community, raising the question of whether public sector organisations should provide funding in the future in return for environmental benefits that accrue to the local population.
- **Barrier 4** – Market availability of the vehicle technology does not appear to have been a problem in this case, but can often be when decisions are made to purchase innovative technology.
- **Barrier 5** – Realising the benefits of the driver training will require buy in from the drivers themselves to follow through on what they learn.

#### D1.2 Drivers

- **Driver 1** –The key driver appears to be linked to SMILE measure 6.1 in that Skånemejerier wish to be able to continue to do business (i.e. make deliveries) in the environmental zone of the City of Malmö.
- **Driver 2** – Skånemejerier have also taken a strategic decision to invest in vehicles with a lower impact on climate change.
- **Driver 3** – The switch in management at some point during 2007. A new CEO with a more positive approach to incorporating environmental concern into business operations and

making use of the environment in marketing. The accelerated procurement of the last five vehicles occurred as a result and a return to heavy eco-driving was made.

## D2 Participation of stakeholders

- **Stakeholder 1** – Skånemejerier – private dairy / distribution company who own and operate the new clean vehicles and employ the drivers who have been trained.
- **Stakeholder 2** – Eon is a key actor for Skånemejerier to achieve 100% biogas fuelling of its vehicles because they produce and supply the biogas.
- **Stakeholder 3** – The public authorities who have been involved in specifying the environmental zone of the City of Malmö are indirectly involved because they have played a part in driving Skånemejerier towards specifying a particular level of environmental standard for the new vehicles purchased.
- **Stakeholder 4** – Skånemejerier's lorry drivers are a key stakeholder in ensuring that the lessons learned are put into practice over a long period of time (ideally to be backed up by refresher training) because it is the drivers themselves who need to implement what they learn when they are driving in real world situations.
- **Stakeholder 5** – Driver training organisations which need to exist in order to provide training.
- **Stakeholder 6** – Vehicle manufacturers who need to be able to offer vehicles to whatever standard is specified by the purchaser / those who set the standards for a city environmental zone.
- It is strange that Skånemejerier has not marketed the activities undertaken in SMILE as part of an environmental/green/climate friendly campaign in order to enhance its public image with either the general public or its customers, even though making such a change was seen as a driver for participation in the measure. It is purely speculation, but we wonder if this was done in 2005-2006 privately to enhance the company image with its customers without alerting its competitors – i.e. to gain competitive advantage, which is natural for a private company.
- Eon's decision to offer "fuel gas" primarily makes it more difficult for organisations wanting to physically fuel their vehicles with 100% biogas. Presumably Skånemejerier is too small an actor in and of itself to effectively influence the decisions on biogas taken by Eon. Furthermore, Eon's decisions are part of a general trend in Skåne, the region Malmö is in, to market fuel gas in order to facilitate getting biogas onto the market as it takes less effort (we assume) this way than to market biogas as a separate product.

## D3 Recommendations

- **Recommendation 1** – Given that the marginal cost of training the drivers (30 000 SEK) is a very profitable activity compared to the reduced costs for fuel, it should receive more active support. Therefore, it is strongly recommended that heavy eco-driving is routinely followed up by:
  - Training **all** drivers, even those not driving primarily in Malmö
  - Refresher training so that the lessons learned are not forgotten over time
  - The installation of on-board equipment that passively monitors fuel consumption with monthly statements of fuel consumption as a form of feedback to the driver and/or more active monitoring where the vehicle "signals" to the driver that he/she is exceeding certain parameters.

- Changes to management procedures to highlight the benefits and incentivise staff based on the fuel consumption savings made.
- Skånemejerier makes a strategic decision with regard to eco-driving to ensure that a programme is in place for regularly-scheduled refresher training.
- **Recommendation 2** – Public sector organisations to consider the level of emission requirement set as part of any low emission zone and the impact that it will have on vehicle operators so that the investment cost and resulting benefit are in balance with any public sector financial support that is available.
- **Recommendation 3** – It appears to be in everybody's best interest that where investment in clean technology is effective that this fact is communicated in order to speed uptake. However, the exception to this is where private sector organisations perceive a competitive advantage that they can exploit. In such cases the public sector needs to actively promote the changes and wherever possible contractual arrangements should be used to ensure co-operation from private sector partners.
- **Recommendation 4** – A degree of training will be required for those who need to be involved in the maintenance of the new vehicles due to differences in procedures for gas vehicles and the new cooler systems. Ideally this will involve a fail-safe form of agreement to ensure maintenance takes place to an agreed schedule.

#### **D4 Future activities relating to the measure**

This measure appears to have been successful from a technical perspective. From a financial perspective the effectiveness of the vehicle upgrade for the private sector company involved is unclear, whilst the driver training appears to have generated positive results.

On this basis it appears that eco-driver training packages should be followed through more widely and that they should be followed up by refresher courses to ensure that the benefits are not lost.

Given that the introduction of the environmental zone in the City of Malmö was a key driver it is likely that clean vehicles will be used by other distribution companies in order to be able to continue to do business there and it will be important to understand the wider costs and benefits of this initiative as opposed to those that can be isolated from a small number of vehicles as in this measure.

Between May 2007 and May 2008 Skånemejerier underwent a reorganisation and has a new CEO who appears to have a more positive relationship to parts of the SMILE measure. Future activities may come to be greater than could have been expected during the first half of SMILE. The reawakened interest in eco-driving with some refresher training, albeit belated, can be taken as an example of new management signals and priorities. These changes occurred in Skånemejerier without the knowledge of the technical evaluator who could not adjust the evaluation in time to meet changing circumstances.