# ICARUS-4

# A database of energy reduction options for the Netherlands, 1995-2020

## Sector study for the Metals Products and Electrotechnical Industry

(SBI/NACE 28-32, 34-35)

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# Abstract

In this report we describe the energy consumption in 1995 and the energy saving options that exist within the metal products and electrotechnical industry (SBI/NACE 28-32, 34-35) in the Netherlands. The data will be included in the ICARUS-4 database which gives an inventory of the technological options for energy savings for all economic sectors in the Netherlands. For all described measures the report provides data on the achievable energy savings up to the year 2020, investment and O&M costs and actual penetration data in the base year of 1995.



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# Contents

# 1. Introduction

## 1.1. General

The sector of the metal products and electrotechnical ('metal-electro') industry comprises several activities within the so-called "light industry". The sector manufactures and assembles different kinds of metal or electronic products for other industries or for final consumers. The SBI /NACE sectors that we will include within this ICARUS sector are the following:

SBI 28: manufacture of fabricated metals;
SBI 29: manufacture of machinery and equipment;
SBI 30: manufacture of office machinery and computers;
SBI 31: manufacture of electrical machinery and apparatus;
SBI 32: manufacture of radio, television and telecommunication equipment
SBI 34: manufacture of motor vehicles, trailers
SBI 35: manufacture of other transport equipment

Note that SBI 33, manufacturing of medical, precision and optical instruments, is not included. This SBI sector will be included in the ICARUS sector "Other industry", mainly because this is done in the same way in the national energy statistics.
The sector produces a very large diversity of products which makes it nearly impossible to establish physical production data. The only exceptions to this are the automobile and bicycle industries for which the number of produced cars / bicycles is known. The sector employs about 310.000 workers in 21.000 companies, which results in average company size of 15 employees. This shows that the sector includes a large number of small companies, although there also a few very large companies such as the electrotechnical company Philips.
The sector a whole is relatively energy-*extensive*, with costs of energy which are only 2-4% of the value added [CBS, 2000]. These two factors: the large amount of small companies and the low energy cost share make the metal-electro sector a difficult sector to achieve energy efficiency improvements.
At present there are two Long Term Agreements on Energy Efficiency between the metal-electro industry and the government, one with the metal coating industry and one with the company Philips [Novem, 1993, Novem, 1999]. These two LTA's cover about 18% of the primary energy consumption within the sector.

## 1.2. Energy consumption 1995

The energy consumption data for the whole sector for 1995 are given in table 1.1 below.

| | Final energy consumption (PJ) | Primary energy consumption (PJ) |
|---|---|---|
| electricity | 14.9 | 37.3 |
| natural gas | 22.7 | 22.7 |
| oil | 10.2 1) | 10.2 |
| coal | 0.06 2) | 0.06 |
| heat | 0.7 | 0.8 |
| **Total** | **48.6** | **70.9** |

Table 1.1 Energy consumption in the metal-electro sector for 1995 [CBS, 1996].
Notes:
1) Including 9.2 PJ for non-energetic use.
2) Entirely for non-energetic use.

We see that the consumption of coal was negligible at 0.06 PJ, which was all used for non-energetic purposes. The consumption of oil was 10.2 PJ of which 9.2 PJ was non-energetic

use. This non-energetic use of oil products is located in the sectors 31-32[1]. Because the energetic use of other fuels than gas is rather small (1 PJ), we will focus further on gas and electricity consumption.
With a total final energy consumption of 48.5 PJ the metal-electro sector is responsible for about 7% of the final energy consumption by the Dutch industry. The total primary energy consumption was 71 PJ[2].

## 1.3. Division into subsectors for ICARUS

We will now try to make a suitable subdivision of the metal-electro industry for the investigation of energy consumption data and energy reduction options within ICARUS.
As a starting point we will use the CBS division into subsectors as given in the financial-economic part of energy statistics ([CBS, 2000], table 9.5). This subdivision is based on three-digit SBI classification. Because the standard SBI division is too detailed and not very suitable for our purposes we will try and make a new subdivision of subsectors which are more or less homogeneous with respect to their energy use.

In fig. 1.1 we give an overview of the gas and electricity consumption data for the different SBI subsectors, as given by the CBS statistics. If we consider fig 1.1 it is clear that SBI sector 314-6, 32, which comprises manufacturing of batteries, lights, radio/television equipment and “other” electrical equipment and is by far the largest energy consumer with 6.7 PJ of final energy consumption (14.5 PJ primary). This subsector is dominated by the company Philips which has activities in manufacturing of lights, semiconductors and electronic equipment. Philips is responsible for about 50% of the (primary) energy consumption within SBI 314-6,32. Other significant subsectors are for example SBI 287 (‘Other fabricated metal products[3]’), SBI 341 (“automobiles”) and SBI 281,283.

Because of the large diversity of processes and products it is not easy to make a sensible division into subsectors which are more or less homogeneous regarding their energy consumption and energy functions. From sector studies it is known that relatively little energy is consumed directly for processing, but rather for the general facilities. Especially space heating is estimated to be responsible for some 50% of the gas consumption in most subsectors. For this reason we have depicted in fig 1.2 the energy consumption per worker.
If we study this figure we see that the average gas consumption is 75 GJ per worker while the average electricity consumption per worker is about 50 $GJ_e$/w. We can also notice that the following subsectors have relatively high energy consumption per worker:

- SBI 285 “Coating of metals”,
- SBI 287 “Steel containers and other metal products”
- SBI 313 “Insulated wire and cable”,
- SBI 314-6,32 “Batteries, lights, electrical equipment”
- SBI 341 “Automobiles”
- SBI 354-355 “Bicycles”

In subsector 285 the processes for surface treatment of metal products, like zinc coating, are mainly responsible for the relatively high gas consumption. In subsectors 287, 341, 353-4 the muffling furnaces where products are heated after application of paint, are probably major

[1] Because of the dominance of one company CBS cannot disclose for what purpose this non-energetic consumption is used. It might be that it concerns the production of anodes for primary aluminium smelters by Aluchemie.
[2] Like in the LTA reports and in other ICARUS sector studies we calculate primary energy requirements by assuming a conversion efficiency of 0.4 for electricity and 1.0 for gas, coal and oil. For heat we use a conversion efficiency of 0.85.
[3] Probably the manufacturing of steel drums and containers is significant within this subsector, therefore we will further designate it as “Steel containers and other metal products”.

energy consumers. We do not know what processes in subsector 313, the wire and cable industry, cause the high electricity *and* gas consumption.
The relatively high electricity consumption in SBI 314-6,32 may be due to the semiconductor manufacturing at Philips where clean room facilities are a major (electricity) consumer.

Based on the absolute and relative energy consumption data in figs. 1.1 and 1.2 we come to the following division into subsectors for ICARUS:

| **Icarus sector** | **SBI** | **Fuel cons.** [1] **(PJ)** | **Electr. cons.** [1] **(PJe)** | **Primary energy cons. (PJ)** | **Share of primary cons.** |
|---|---|---|---|---|---|
| Metal coating | 285 | 1.3 | 0.6 | 2.9 | *5%* |
| Steel containers & other metal products | 287 | 2.1 | 1.0 | 4.7 | *8%* |
| Insulated wire and cable [2] | 313 | 0.3 | 0.4 | 1.5 | *2.5%* |
| Lights and electrical equipment | 314-6, 32 | 4.7 | 3.9 | 14.5 | *24%* |
| Automobiles | 341 | 1.4 | 0.8 | 3.6 | *6%* |
| Other metal-electro | 281-4, 286, 29, 30, 311-312, 342-3, 35 | 12.8 | 8.0 | 33.4 | *55%* |
| **Total** | **28-32,34-35** | **22.7** | **14.9** | **60.5** | ***100%*** |

Table 1.2: Discerned ICARUS subsectors within the sector of metal-electro industry and their energy consumption in 1995 [CBS, 1996, CBS, 2000].
Notes: 1) Gas and electricity consumption data were taken from the financial economic statistics and scaled up with a factor 1.21 resp. 1.24 to bring them into accordance with energy balance data for the whole sector (see table 1.1).
2) This subsector is relatively small, it is split off primarily to get a more homogeneous group for "Other metal-electro". For the same reason we will not discuss specific energy reduction options for this sector but only apply the sector-wide options.

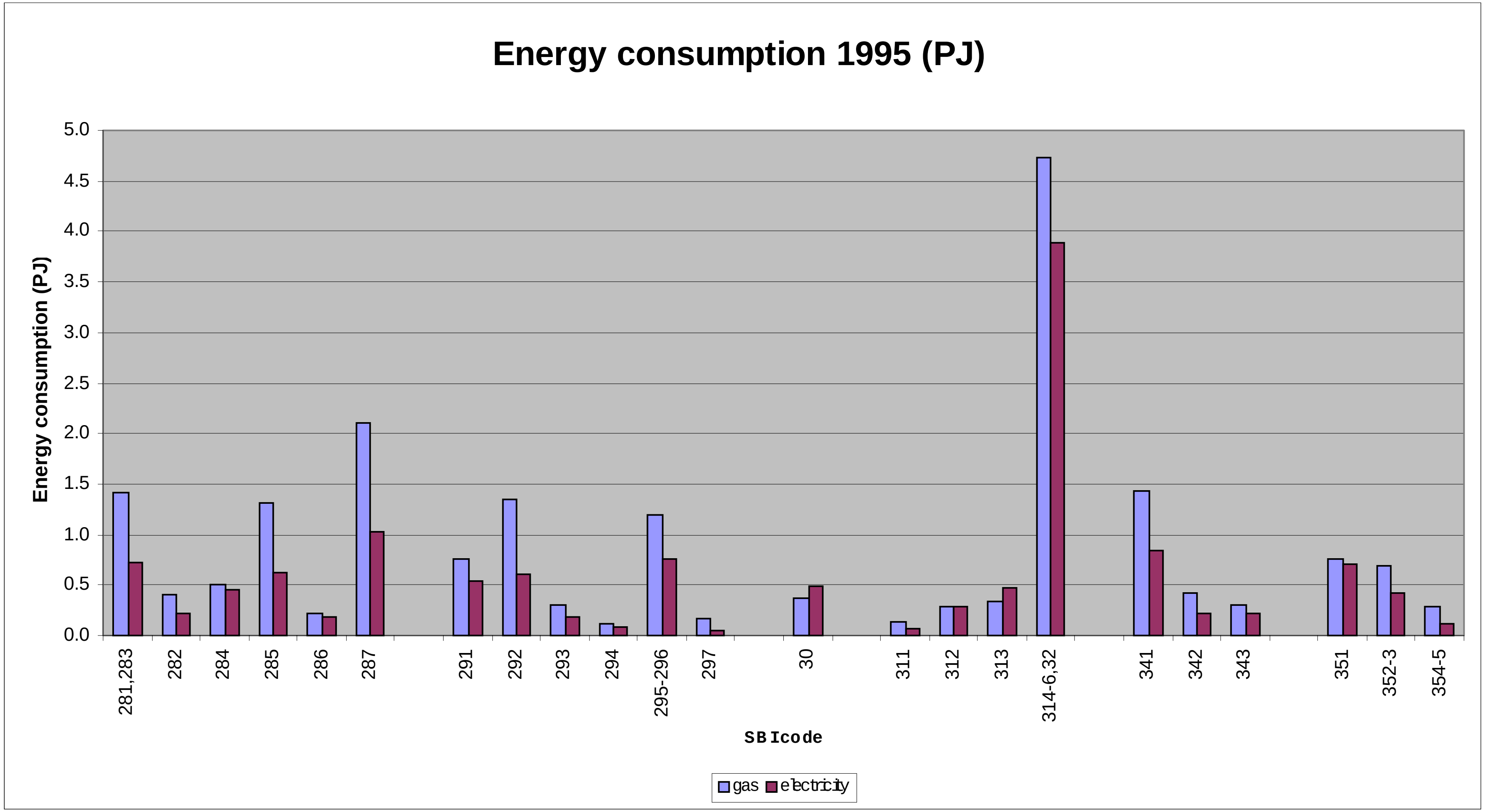


Fig. 1.1: Gas and electricity consumption in the metal-electro industry per SBI/NACE subsector (1995) [CBS, 1996, CBS, 2000].

Notes:

1) Gas and electricity consumption data from the financial economic statistics were scaled up with a factor 1.21 resp. 1.24 to bring them into accordance with energy balance data for the whole sector.

2) Energy use data for companies employing less than 20 workers were omitted from the figure (but not from the data set).

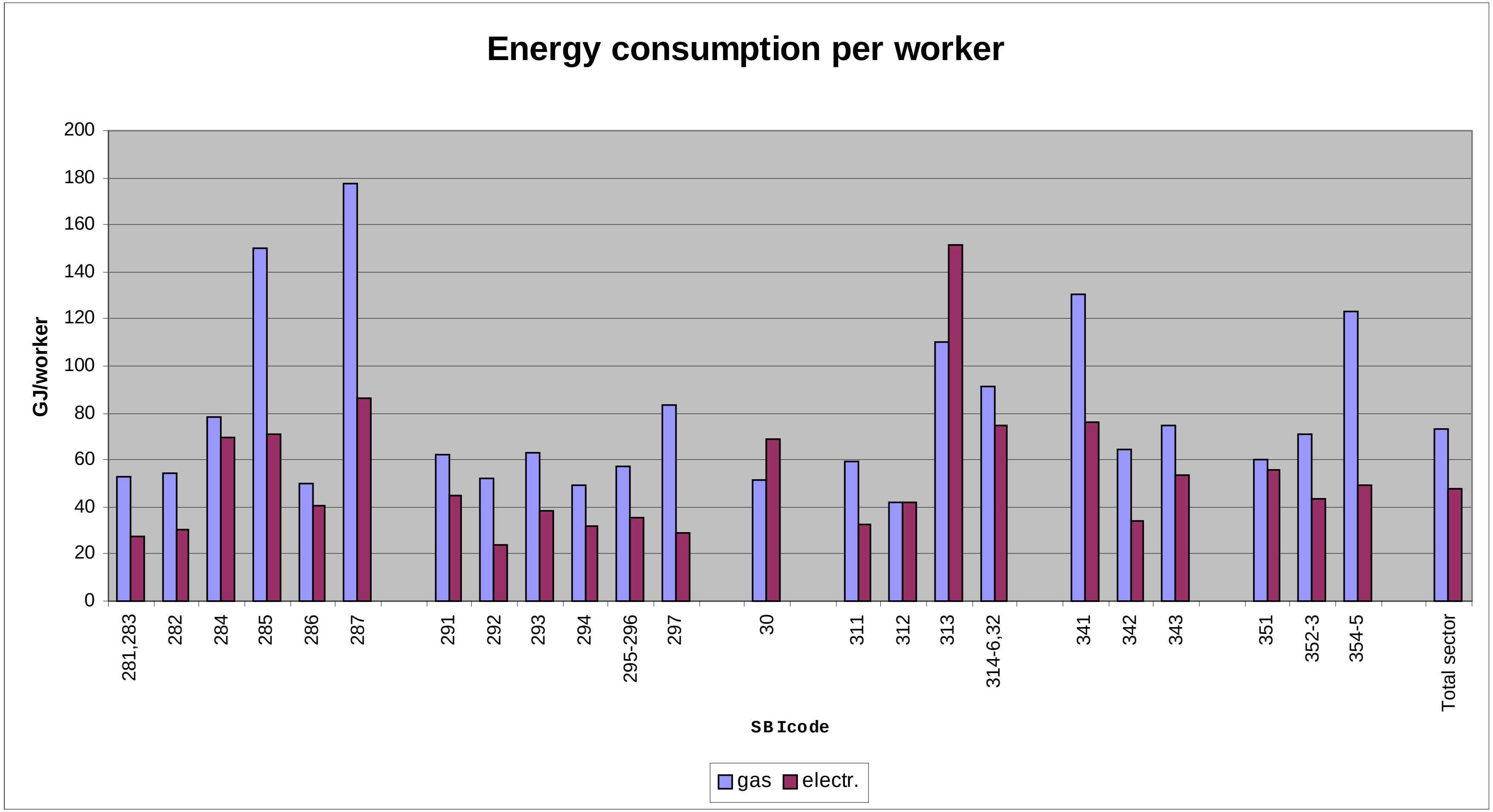


Fig. 1.2: Energy consumption per worker for metal-electro industry (1995, see also the notes with fig. 1.1) [CBS, 1996, CBS, 2000].

Now that we have split off the relatively energy-intensive subsectors (first five subsectors in table 1.2) the remaining industry is somewhat more homogeneous with respect to their energy consumption. If we look at the gas consumption per worker for the ICARUS subsector “Other metal-electro”, we find that it is 60 ±14 GJ per worker. For electricity the results are less convincing: 37 ± 14 $GJ_e$ per worker. Although these data probably hide a large variety of processes and thus reduction options we have no better alternative than to treat it as one sector within ICARUS.
It is unfortunate that we still have such a large share of the energy consumption in one rest category, but at least we have split off the relatively energy-intensive subsectors.

In the sections 2-5 below we will discuss the discerned ICARUS sectors, followed by a discussion of some sector-wide energy reduction options in section 6.

### 1.4. Energy functions

We will discern the following energy functions within the sectors:

- pretreatment / posttreatment of metal surfaces (cleaning, fluxing, etc);
- zinc coating
- galvanising
- muffling furnaces
- other furnaces
- space heating
- lighting
- clean rooms
- ventilation and air conditioning (other than for clean rooms)
- compressed air
- electric drives

We will now attempt to make first order estimates for some of the generic energy functions like space heating, ventilation and lighting.
It is known that space heating is the major consumer of gas in the considered industry sectors. Estimated shares are 30-70% for different segments of the metal-electro sector [Brouwer, 1994, Brouwer and Nuland, 1994, Novem, 1997, Overboom, 1996]. If we consider the ICARUS subsector “Other metal-electro”, that is the subsector which excludes the industries with energy-intensive processes, it seems reasonable to assume that space heating will be responsible for 60% of the gas consumption within this subsector. As space heating is clearly a person-related energy function and because the average gas consumption in the subsector is about 60 GJ per worker, we can deduce that the gas consumption for space heating is on the average 35 GJ per worker. We will use this estimate as a starting point for our estimate of the energy consumption for space heating in all other subsectors too[4].
In the same way we can make a first estimate for the electricity consumption for lighting as this is also a person-related energy function. Estimates are that 6-18% of total electricity demand in the metal-electro industry is for lighting [Brouwer, 1994, Novem, 1997]. If we assume that a share of 15% is a reasonable value for the ICARUS subsector “Other metal-electro” we come to an average energy demand of 6 GJe per worker for lighting.
Energy demand for ventilation and airco is much more dependent on the kind of activities: one generic estimate gives 15% of the electricity consumption [Novem, 1997]or 6 GJe/w. However in some areas this figure may be much higher.

[4] For some subsectors corrections may be necessary, for example if high ventilation rates are required, the energy demand for space heating will also increase.

# 2. Metal coating industry

## 2.1. Sector description

In the metal coating industry metal products are finished with a coating, usually to protect it against corrosion. Most of companies are contracting firms which coat products in commission by other companies. The following activities may be found within this sector:

- coating of steel products with zinc, using a thermal process;
- coating of steel products with zinc, using a galvanic process;
- anodisation of aluminium products;
- painting and muffling of metal products;
- blasting of metal products.

Some of these activities, especially muffling, can also be found within other subsectors (e.g. automobile industry).

The sector[5] has signed a Long Term Agreement on Energy Efficiency, which projects a 20% efficiency improvement between 1989 and 2000, a target which will probably be achieved within a close margin. A second LTA is being prepared for 2000-2005.

It is not known what the shares of these different activities are (either in $m^2$ coated product or in energy consumption). We will assume the following energy functions and their respective shares in gas / electricity use:

| **Function** | **Gas (TJ)** | | **Electr. (TJe)** | | **Prim. energy (TJ)** | |
|---|---|---|---|---|---|---|
| Space heating | 220[3)] | *17%* | | | 220 | *8%* |
| Lighting | | | 55[4)] | *9%* | 140 | *5%* |
| ventilation +airco | | | 60[5)] | *10%* | 150 | *5%* |
| heating of pre- and post-treatment baths[1)] | 280 | *21%* | 220 | *35%* | 830 | *29%* |
| thermal zincing | 380 | *28%* | | | 380 | *13%* |
| galvanic coating [2)] | | | 80 | *13%* | 200 | *7%* |
| muffling | 300 | *23%* | | | 300 | *10%* |
| other | 140 | *11%* | 215 | *34%* | 680 | *23%* |
| **Total** | **1320** | ***100%*** | **630** | ***100%*** | **2900** | ***100%*** |

Table 2-1: Energy functions within the metal coating industry (SBI 285), with their assumed shares. Process energy estimates were based on [M+I, 1999 #29].

Notes: 1) including heating of galvanisation baths
2) including anodisation;
3) assuming 25 GJ/worker and 8800 workers;
4) assuming 6 GJe/worker and 8800 workers;
5) assuming 9 GJe/worker for the 4000 workers in SBI 285.1 and 5.5 GJe/worker for the 4800 workers in SBI 285.2 (see also footnote 5).

Note that the above allocation between energy functions is partly based on industry case studies, but is still rather tentative.

## 2.2. Energy reduction options

Energy reduction options regarding general facilities (space heating, lighting, ventilation, airco) will be discussed in section 6.

[5] Actually SBI code 285 comprises two different branches, 285.1 with the metal coating industry and 285.2 with other metal processing activities (drilling, turning, milling). Only part of the first branche, with about 45% of the sector's workers and also 45% of the turnover, is included in the LTA. This makes it difficult to reconcile LTA monitoring data with CBS energy data. We have made estimates on energy consumption for the major processes based on [M+I, 1999 #29] and used these as the basis for table 2.1.

Significant reduction options can be found around processing baths in matal coating facilities. Pre- and posttreatment baths for degreasing, etching, fluxing and sealingare often kept at temperatures of 30-70 $^{o}$C. Heating is done indirectly with hot water or steam, or directly by electrical heating elements. This kind of baths is found in all branches of the metal coating industry.
In thermal zincing facilties molten zinc is kept in dipping baths at a temperature of 450 $^{o}$C. These baths must be kept at same temperature during the night because the zinc would otherwise solidify. In uncovered zinc baths the heat loss from the surface and the walls accounts for 35 % of the energy input.
Therefore a first option to reduce energy consumption is to reduce the heat losses from process baths with *covers on zincing baths* and also *wall insulation and (night) covers on process baths*. This measure may reduce the gas consumption for thermal zincing and for heating of pre- and post-treatment baths with 10% -30% [Novem, 1997, IDEE, 2000 #2]. The investment costs are estimated at 4 €/(GJ/yr) so that we get a simple Pay-Back Time[6] (PBT) of 0.9 yr for gas-heated baths[7]. We will further assume a penetration in 1995 of 10% for this measure, but since then the penetration has significantly increased to probably around 70% in 1999. This measure has also important benefits regarding the labour conditions (less fumes). Table B- 1, Table B- 2 and Table B- 12 give a full description of these measures[8].

A second measure that applies to pre- and post-treatment baths is direct heating with a *submerged gas burner*, instead of the usual system where the bath is heated indirectly with steam or hot water. Energy savings of 30-70% may be realised if indirect heating is replaced and investment costs range from 35 € per kW for 400 kW burners to 140 € per kW for 50 kW installations [Novem, 1997]. Assuming an energy saving of 50% during 2000 hours per year, gives an investment cost of 10 – 40 €/(GJ/yr). We assume a value of 25 €/(GJ/yr), which is equivalent to Pay-Back Time of 6 yr. When replacing electrical heaters we may assume that 1 GJ of gas is used extra for each GJe of saved electricity. Investment costs can in this case be calculated as 3-12 €/($GJ_p$/yr). If we assume 8 €/($GJ_p$/yr), then the PBT is 1 yr. The current penetration of this measure is low, probably 0%, and we assume that 50% of the baths is suitable for this technology. Table B- 3 and Table B- 13 describe this measure for gas respectively electrically heated baths.

Another measure regarding process bath heating is *heat recovery* from the exhaust gases of the zinc bath heater. The recovered heat may be used to heat the pretreatment baths making the conventional central boiler system practically obsolete. We will assume an 80% savings percentage. Investment costs are in the order of 20 €/(GJ/yr) (PBT= 4.5 yr) when replacing indirect gas heating[9]. Obviously this measure can only be applied at zincing plants. Because we estimate the gas consumption for pretreatment baths in these plants at 80 TJ (out of 280 TJ for the entire subsector), the technical maximum penetration for the replacement of gas fired central boilers would be about 28%. A second limitation is the heat recovery scheme cannot be combined with the option of submerged gas burners which was described above. If we assume that heat recovery can be applied to the subset of the pretreatment baths that was not

[6] Simple Pay-Back times are calculated by dividing the investment costs by the yearly saved energy costs. For the *metal products industry* we assume energy costs of 4.45 €/GJ (f 0.30 /m$^3$) for gas and 7.40 €/GJp (f 0,15 /kWh) for electricity. For the *electrotechnical* industry we assume energy costs of 3.70 respectively 5.95 €/GJp for gas and electricity (i.e. f 0.26 /m$^3$ resp. f 0.12 /kWh).
[7] For electrically heated baths the investments costs, expressed per GJ of saved *primary* energy, are a factor 2.5 lower, that is 1.6 €/Gjp/yr, and the PBT is 0.2 yr.
[8] In the tables in *Appendix B* the energy saving measures identified above are fully described with all data as they will be included in the ICARUS database. Appendix A gives an explanation of the meaning of the different fields in the tables.
[9] Here too, the *relative* investments costs when replacing electrical heating are a factor 2.5 lower.

suitable for submerged gas burners, we come to maximum penetration of 14%[10]. The actual penetration of this measure in 1995 was zero, and 1999 it is still very low, may be 2%. (Table B- 4 and Table B- 14).
*Spraying tunnels* can be a long term option for pretreatment of metals which can supplant the dipping baths which are now used throughout the industry. We will assume that this saves 80% on pretreatment bath energy, and that there are no additional investment and O&M costs, if compared to the standard technology of dipping baths. The maximum penetration is assumed to be 50% (Table B- 6).

Because zinc baths are a major energy user within the sector the application of *improved burner* technologies, e.g. ceramic burners, is an important option, providing savings of 30% on the gas use for thermal zincing. This measure has not yet been implemented in 1999 (Table B- 5).

Improvement of product logistics *can also have significant impacts on energy efficiency because it increases the effective operational time of baths and thus reduces standby losses.* We will assume that such measures may reduce energy consumption of pretreatment and zinc baths by 10% at costs of 10-20 €/(GJ/yr) (cf. [IDEE, 2000a]). The Pay-Back Time is 2.2-4.5 yr for the gas savings (Table B- 7, Table B- 15, Table B- 8).

A second significant use of process energy within the sector of metal coating is in muffle furnaces, where painted or powder coated objects are heated to 120-250 $^{o}$C so that the coating will cure. It has been estimated that the primary energy use for lacquer application and muffling is 6 MJ/m$^2$ [Novem, 1997]. Several options to improve the energy efficiency of muffle furnaces have been identified [Novem, 1997], like improved wall insulation, heat recuperation, minimisation of heat losses through entrance/exit openings, and keeping the conveyer belt within the furnace. With these kind of retrofit measures energy savings of 20-50% are expected at investment costs of 3-15 €/(GJ/yr). We will asume savings of 35% and additional investments of 9 €/(GJ/yr) (PBT = 2 yr). See Table B- 9.
Some newer techniques which may be applied on the medium to long term are:

- infra-red furnaces
- low-bake coatings
- UV-curing

With *infrared furnaces* the energy efficiency can be increased with 50-70% [Caddet, 2000b, IDEE, 2000d, Novem, 1997]. The IR heaters can be either gas-fired or electrical. Electrical IR heaters have been demonstrated in the automobile industry. IR furnaces may also give significant savings on O&M costs [IDEE, 2000d], for this reason we will assume that the net additional costs are zero. Bottlenecks for the introduction of IR furnaces are problems with shadowing and the hardness of the resulting coating. We will assume 60% savings, a maximum penetration of 50% and no additional investments (Table B- 10).
The technology of *low-bake coatings* is based on new types of coating material which can be cured at temperatures below 100 $^{o}$C. We assume that this gives energy savings of 50% and a maximum penetration of 75% (Table B- 11).
No further information was available on UV curing.

[10] For replacement of electrical heaters in zincing facilties we estimate a technical maximum pentration of 20%.

# 3. Steel containers and other fabricated metal products

## 3.1. Sector description

This subsector (SBI/NACE 287) is a bit of a mixed lot of remaining activities within SBI 28. One major activity is the manufacturing of steel drums and food cans, but it also comprises the manufacturing of nuts and bolts and of metal household products. No information was available regarding the relative importance of these various activities or the major energy consuming processes. The total gas consumption in 1995 was 2.1 PJ and the electricity consumption 1.0 PJe.
It might be that muffling is a major energy consuming process within this subsector.
We will assume the following division into functions:

**Table 3-1: Break-down of energy demand for SBI subsector 287.**

| | Gas | | Electricity | | Primary energy | |
|---|---|---|---|---|---|---|
| **Function** | **PJ** | | **PJe** | | **PJp** | |
| Space heating | 0.6 | *30%* | | | 0.6 | *14%* |
| Lighting | | | 0.1 | *10%* | 0.3 | *5%* |
| Ventilation +airco | | | 0.2 | *20%* | 0.5 | *11%* |
| Muffling | 0.6 | *30%* | | | 0.6 | *14%* |
| Other | 0.8 | *40%* | 0.7 | *70%* | 2.6 | *56%* |
| **Total** | **2.1** | ***100%*** | **1.0** | ***100%*** | **4.7** | ***100%*** |

Note that the values in table 3.1 are very tentative.

## 3.2. Energy reduction options

Energy reduction options relating to general facilities will be discussed in 6, while options relating to muffling furnaces have already been discussed in section 2.2. (Table B- 18, Table B- 19, Table B- 20)

# 4. Lights and electronic equipment

## 4.1. Sector description

The SBI/NACE sectors 314-6, 32 comprises the manufacturing of all kinds of electrical and electronic equipment with *exclusion* of electric motors, generators, transformers, switches and cables. Major activities within this subsector are the manufacturing of lights and semiconductors at Philips. Philips is the dominating company within the sector which employs about 45.000 people and has it's major activities in semiconductor manufacturing, fluorescent lights, shavers and medical systems. Philips also has a glass production facility within its lighting division but this falls outside the scope of this SBI sector[11]. Since 1993 there is a Long term Agreement on Energy Efficiency between Philips and the government to improve energy efficiency with 25% between 1989 and 2000. In 1999, however, Philips had already achieved an improvement of about 35%.
The entire subsector consumes about 3.9 PJe of electricity and 4.7 PJ of natural gas, a small amount of oil (14 TJ) and some warm water and steam from cogeneration plants. With 14.5 PJ primary demand the subsector is responsible for about 25% of consumption in the entire metal-electro sector.

A rough estimation of the division between energy functions is given in table 4.1.

| | Gas | | Electricity | | Primary energy | |
|---|---|---|---|---|---|---|
| **Function** | **PJ** | | **PJe** | | **PJp** | |
| furnaces | 1.4 | *30%* | 0.8 | *20%* | 3.4 | *23%* |
| clean rooms | | | 0.6 | *15%* | 1.5 | *10%* |
| space heating | 1.9 | *40%* | | | 1.9 | *13%* |
| ventilation and airco 1) | | | 0.6 | *15%* | 1.5 | *10%* |
| lighting | | | 0.4 | *10%* | 1.0 | *7%* |
| other | 1.4 | *30%* | 1.6 | *40%* | 5.3 | *37%* |
| **Total** | **4.7** | ***100%*** | **3.9** | ***100%*** | **14.5** | *100%* |

Table 4-1: Breakdown of energy consumption between functions within ICARUS subsector "Lights and electronic equipment".

Notes: 1) Ventilation other than for clean rooms.

Note that the values in table 4.1 are rather tentative.

Furthermore note that because of the extensive use of clean room facilities within semiconductor manufacturing (and also in other activities within this subsector) we estimate a fairly high energy consumption for this specific application. In semiconductor manufacturing very high standards are required for clean, dust-free air in the rooms where wafers are handled.
Under clean room facilities we therefore comprehend the extraction, cleaning and cooling of air to obtain a precisely-controlled atmosphere. Analysis of semiconductor facilities in the USA has shown that about 50% of their energy consumption is spent on air handling. The total energy consumption can vary between factories, in the range of 120 to 450 kWh/wafer [VanLeeuwen, 1997]. We estimate that in the Netherlands about 0.6 PJe is used in semiconductor manufacturing so that the use for clean room facilities in this industry might be around 0.3 PJe. Because clean rooms are increasingly applied outside the semiconductor industry (be it with more relaxed dust-control standards), we think that the total electricity consumption be clean rooms in the entire subsector may well be around 0.6 PJe.

[11] According to the SBI/NACE definitions glass production for lamps falls under SBI 26.15. However, the LTA on Energy Efficiency for Philips does include the glass production plant.

## 4.2. Energy reduction options

Energy reduction options relating to general facilities will be discussed in section 6. Here we will investigate options with regard to furnaces and with regard to clean rooms.

Furnaces are used in this subsector for:
- curing of coatings;
- preparation of ceramic components;
- drying.

Process analyses at Philips have shown that the energy efficiency of the heat transfer to the product is often quite low, in the order of 2-10%, so there seems to be much room for improvement. Furthermore we have to keep in mind that both gas-fired furnaces and electrical furnaces are being used.
In section 2.2 we have already discussed some options for optimisation of muffle furnaces, such as minimisation of heat losses through openings and heat recuperation. Because some of the muffle furnace options are less applicable in gas-fired furnaces in general (e.g. increased air recirculation) we will assume slightly lower savings of about 30% can be realised at the same additional investments of 9 €/(GJ/yr). The PBT is then 2.4 yr (Table B- 27).
Similar optimization of electric furnaces will again have a somewhat lower savings potential of say 20% but also lower investment cost per GJ primary saved of 4 €/(GJ/yr), resulting in a PBT of 0.7 yr[12] (Table B- 28).

For furnaces in general some additional savings options can be identified.
In the first place the replacement of electrical furnaces by of gas-fired types may be considered. Indirect gas heaters may be used if one does not want the product to come into contact with the off-gasses [IDEE, 2000b]. Although this measure will not always reduce the final energy use, it will reduce primary consumption and thus $CO_2$ emissions. We will assume that 50% of the electrical furnaces may be supplanted by gas-fired types at low extra costs of 4 €/(GJ/yr). See Table B- 21.
A second option that may be applied in the case that furnaces are used in batch-type processes is to switch to a flow process so that a tunnel furnace can be applied. Tunnel furnaces are much more energy-efficient because you avoid start-up and cooling off losses which are often considerable. In one project in the production of cathode ray tubes for televisions an energy saving of more than 60% was demonstrated at additional investment cost of 19 €/(GJ/yr) [IDEE, 2000e]. We will assume that for 20% of all furnaces a switch to a gas-fired tunnel furnace is possible, resulting in average energy savings of 30% per case. We will assume that the average additional investment costs of tunnel furnaces are 20 €/(GJ/yr) so that we get a PBT = 4.5 yr (Table B- 22 and Table B- 23).

In clean rooms further compartmentalisation can reduce air flow volumes and thus energy consumption significantly. In an extreme form of compartmentalisation the wafers are kept in small containers during transport between different pieces of processing equipment (this is the “SMIF”-system or also “mini-environments”). Because only the air in the small transport containers needs to be conditioned there is a large reduction in air volume that needs filtration and conditioning. A great advantage of the SMIF system is that it also reduces the chance of contamination of wafers and thus increases the yield of the production process[13].
Another option to reduce air handling demands is full automation of the wafer handling. By avoiding all contact with human operators the demands on the air handling will also be greatly reduced. We have no specific data on the achievable energy reductions and costs of these measures. However, it is expected that by these kind of measures and by other autonomous trends in semiconductor manufacturing (e.g. wafer size increase) the energy

[12] For the *electrotechnical* industry we assume energy costs of 3.70 €/GJ respectively 5.95 €/GJp for gas and electricity (i.e. f 0.26 /$m^3$ resp. f 0.12 /kWh) when calculating the Pay-Back Time.
[13] Given the large number of processing steps and the high capital costs the production yield is probably the major cost driver in the semiconductor industry.

demand per unit wafer area will go down in the future [VanLeeuwen, 1997]. We will assume a 30% savings at no additional costs. The current penetration of the SMIF system is estimated at 20% within the semiconductor industry. Based on our estimate that 50% of clean room energy consumption is located outside the semiconductor industry, we obtain a current penetration of 10% among all clean room facilities. For the same reason the maximum penetration of mini-environments is 50% (Table B- 24).

We already mentioned that clean rooms are used increasingly outside the semiconductor industry, too. Not in all cases these investments are based on a realistic assessment of the requirements for a clean atmosphere. And here too, compartmentalisation can result in a significant down-sizing of the air handling system.

We will assume here that compartmentalisation and realistic assessment of clean room requirements can reduce the energy demand for clean rooms by 30% in non-semiconductor industries at low costs of 5 €/(GJ/yr) and a PBT of 1 yr (Table B- 25).

Finally we want to mention the possibility of heat recuperation in the air conditioning system of clean rooms. We will assume that with heat recuperation an additional 15% energy saving can be achieved at costs of 25 €/(GJ/yr) (PBT= 6 yr). The current penetration of this measure is probably zero (Table B- 26).

# 5. Automobile industry

## 5.1. Sector description

The subsector of the “motor vehicle manufacturing” (SBI/NACE 341) is not very significant in the Netherlands[14]. In 1994 the industry produced 92.000 passenger cars and 13.900 business vehicles[15] . It is relatively a energy-intensive activity in comparison with other metal-electro industries, at least in terms of energy consumption per worker (fig. 1.2). The electricity consumption was 0.8 PJe, the gas consumption 1.4 PJ and the primary energy consumption 3.6 PJ which is 6% of metal-electro sector total.
No detailed data on the energy consumption for various functions was available but we expect that muffling furnaces, compressed air supply and electric drives are important energy consumers specifically for this subsector. In table 5.1 below we give our assumptions regarding the break-down of the energy demand.

| | **Gas** | | **Electricity** | | **Primary energy** | |
|---|---|---|---|---|---|---|
| **Function** | **PJ** | | **PJe** | | **PJp** | |
| muffle furnaces | 0.43 | *30%* | | | 0.4 | *12%* |
| other furnaces | 0.14 | *10%* | 0.08 | *10%* | 0.4 | *10%* |
| space heating | 0.43 | *30%* | | | 0.4 | *12%* |
| ventilation and airco 1) | | | 0.13 | *15%* | 0.3 | *9%* |
| lighting | | | 0.08 | *10%* | 0.2 | *6%* |
| compressed air | | | 0.08 | *10%* | 0.2 | *6%* |
| electric drives | | | 0.17 | *20%* | 0.4 | *12%* |
| other | 0.43 | *30%* | 0.29 | *35%* | 1.2 | *33%* |
| **Total** | **1.43** | ***100%*** | **0.84** | ***100%*** | **3.5** | *100%* |

Table 5-1: Breakdown of energy consumption between functions within ICARUS subsector “Automobile industry”.

Note that the values in table 5.1 are very tentative.

## 5.2. Energy reduction options

Energy reduction options relating to general facilities like space heating, ventilation, compressed air will be discussed in section 6.

In section 2.2 we already discussed several options for improving muffling furnaces . Among these the infrared furnace seems to be one of the more interesting options because a number of demonstration project exists for this technology. For the other furnaces (gas and electric) which are not used for muffling the options described in section 4.2 for generic furnaces are assumed to be suitable.

[14] Note that the manufacture of coachwork and car parts is not part of this subsector.
[15] Data for 1995 and later are not available from CBS.

# 6. Sector-wide measures

## 6.1. Introduction

In this section we will describe some measures that may be applied in the entire metal-electro sector. All these measure apply to the generic energy functions that we encountered in the preceding sections. The following energy functions are investigated:

- space heating
- ventilation and air conditioning
- lighting
- compressed air
- electric drives

## 6.2. Energy reduction options

(** Note: The data given in this section are still preliminary and need further verification.**)

Monitoring and targeting is a measure that can be applied in all sectors. We will assume that it can reduce energy consumption with 5-10% at low investments costs of 5 €/(GJ/yr) [Caddet, 2000a].

Four sets of measures can be identified regarding space heating, ventilation and air conditioning [Beer, Wees, 1994]:

1. Optimisation of air conditioners: less make-up air, reduce overdimensioning, better fine-tuning and control may give savings of 10% at 5 €/(GJ/yr) (PBT= 1 yr).
2. Roof insulation, cavity wall insulation, reduction of ventilation rate and ventilation heat recovery. With these measures 15% of the fuel demand for space heating can be saved. Investments are estimated at 25 €/GJ (average; PBT = 6 yr) (see e.g. [IDEE, 2000f]).
3. Compartmentalisation and local ventilation: 10% energy savings at 25 €/(GJ/yr) average investments (PBT = 6 yr; see e.g. [IDEE, 2000c])
4. Floor isolation, heavy wall isolation, double glazing and building optimiser. These measures account for an energy saving of 20% and investments of 70 €/(GJ/yr) (average; PBT = 15 yr).

For lighting two sets of measures are discerned:

1. improved lighting control with savings of 50% and investments costs 20 €/(GJ/yr) (PBT = 3 yr)
2. High-frequency ballasts for fluorescent tubes with savings of 20% and investments of 20 €/(GJ/yr) (PBT= 3yr)

In compressed air systems reduction of leakage, better sizing of compressors and improved control can reduce energy demand with 10-20% at average costs of 5 €/(GJ/yr) (PBT = 0.7 yr).

For electric drives significant reductions can be achieved with high efficiency motors and variable speed drives. We assume total savings of 10% at investments of 30 €/(GJ/yr) (PBT= 4 yr).

# 7. References


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# Appendix A: Presentation of energy saving measures

Energy saving measures are presented in this report using a standard format, shown in the sample table below. The first column gives the name of the information item. The second column specifies the value of this information item. The third column is for comments.

**Table A-1: Sample energy saving measure table**

| | | |
|---|---|---|
| Name of measure | Flue gas heat recovery | |
| (sub)sector code | SBI 261 Glass industry | |
| Energy function | Melting | |
| Savings electricity | 25 % | Uncertainty: [20 ,25]<br>Reliability: M<br>Source: (2,2,4,3) |
| Savings fuel | 25 % | Uncertainty: [20 ,25]<br>Reliability: M<br>Source: (2,2,4,3) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 4. Heat recovery | |
| First year of implementation | 1995 | |
| Penetration base year (1995) | 50% | Uncertainty: [30 ,60]<br>Reliability: L<br>Source: (6,3,10,4) |
| Current penetration (1999) | 0% | |
| Technical maximum penetration | 100% | |
| Additional investments | € 10 /(GJ/yr) | Uncertainty: [7 ,15]<br>Reliability: M<br>Source: (1,1,6,3) |
| Additional O&M costs | € 0,37 /GJ | Uncertainty: [0,25 ,0,5]<br>Reliability: M<br>Source: (1,1,6,3) |
| Economic lifetime | 8 | |
| Implementation Char | 1/1/S/0/M/M/M | |

Explanation to some of the items in this table:

*NUSAP notes*
NUSAP (Numeral, Unit, Spread, Assessment, Pedigree) is a notation system developed by Functovitz and Ravetz (1990) for presenting the quality of data. Not only the number and unit of the number given but also information on uncertainty, reliability and the background of the data is given. For some of the data in the table NUSAP information is given (where possible). The following conventions are used:
*Uncertainty* is represented by ± x% or by [lower bound, upper bound]. The real value should be in this interval with 90% certainty.
*Reliability* is represented by L (=Low), M (= Medium) or H (= High)
*Source* is given with 4 numbers (Origin, Type, Method, Verification), as shown in the following table.

| **Origin** | **Type** |
|---|---|

| | |
|---|---|
| 1. From reviewed literature<br>2. Other public source<br>3. Non-public source<br>4. Written personal information from expert<br>5. Oral personal information from expert<br>6. Own estimate | 1. data for many companies/installations<br>2. data from one realised demonstration project<br>3. data form one project, not a demonstration project<br>4. data from design-study<br>5. data from R&D results<br>6. data from good comparable situations<br>7. data from possibly comparable situations<br>8. target data |
| **Method:** | **Verification:** |
| 1. theoretical deduction<br>2. directly taken from source, without calculations<br>3. directly taken from source, only unit conversion<br>4. taken from source, minor adjustment<br>5. taken from source, major adjustment<br>6. generalisation based on specific situation<br>7. own calculation based on statistical data<br>8. own calculation based on other data<br>9. expert estimate<br>10. own estimate | 1. verified by (other) expert<br>2. internally verified<br>3. compared with other studies/situations<br>4. unverified. |

*(sub)sector code*
Here the Dutch three-digit SBI-93 (SBI = Standaard Bedrijfs Indeling) sector code is specified. This code is equivalent with the NACE Rev. 1 code (NACE=Nomenclature générale des Activité économiques dans les Communautés Européennes).

*Savings electricity/fuel/heat*
Savings presented are savings on the energy used for the energy function mentioned. A negative sign means that an extra amount of this energy carrier is needed in order to achieve saving of the other energy carrier. In this example 25% is saved on the energy use for melting and this measure leads to an extra 5% electricity use for melting.

*Type of measure*
Three values are possible here: *New*, *retrofit* or *good housekeeping*.
*New* means that the measure will only be applied when production capacity is expanded or replaced at the end of the economic lifetime
*Retrofit* means that changes are made to existing installations
*Good housekeeping* means that procedures are in effect that prevent unnecessary losses of energy (e.g., reduction of uncontrolled ventilation in buildings). In theory this type of measure is considered reversible, which means that during low energy prices less attention is payed to good housekeeping.

*Measure category*
One of the following values, based upon a taxonomy of energy efficiency measures by De Beer et al. (1996):

1. Good housekeeping
2. Process control and management
3. Reduction of heat losses through surfaces
4. Heat recovery
5. Process integration
6. Energy recovery other than heat
7. Improved lighting

8. Reduction of friction losses during movement
9. More efficient conversion of electricity in movement
10. New process technologies
11. More efficient kilns and burners
12. More efficient conversion of fuel to work
13. Renewable energy and heat from waste
14. Material options (e.g., secondary materials)
15. Fuel shift

*Additional investments/O&M costs*
These are expressed in Euro (€) per gigajoule (GJ) primary energy saved per year. Actually an approximation is used when these items are expressed in terms of primary energy savings: electricity saved is converted to primary energy saved using an electric power generation efficiency of 40%[16]. No conversion factors are used for fuels and heat. Subsidies will not be considered.

*Economic lifetime*
The economic lifetime is the time during which the capital goods involved with the measure is actually used. Usually the economic lifetime is shorter than the technical lifetime (e.g., because O&M costs increase above an acceptable level or new developments make it attractive to replace existing equipment). The economic lifetime can be longer than the fiscal depreciation period.

*Implementation characteristics*
Seven values with the following meaning:
1. Core production process. The measure affects the core production process (1=yes, 0=no)
2. Standard or customised technology (1=standard, 0 = customised)
3. Technical implementation (P = during production, M = during maintenance, S = during production stop)
4. Side effects (+=positive, 0=neutral, - = negative)
5. Cost uncertainty (H = High, M = Medium, L = Low)
6. Energy savings uncertainty (H = High, M = Medium, L = Low)
7. Production uncertainty (H = High, M = Medium, L= Low)

[16] This efficiency is used for the calculation of additional investments and O&M costs only. It does not mean that the actual efficiency for any year is set to this value.

# Appendix B: Measure description tables

## Coating of metals

### Table B- 1: Insulation and covers on process baths (gas)

| | | |
|---|---|---|
| Name of measure | Insulation and covers on process baths (gas) | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Heating pre/posttreatment baths | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 20 % | Uncertainty: [10 ,30]<br>Reliability: H<br>Source: (2,1,6,3) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 3. Reduction of heat losses through surfaces | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 10 % | Uncertainty: [0 ,20]<br>Reliability: H<br>Source: (5,1,2,4) |
| Current penetration (1999) | 70 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 4 /(GJ/yr) | Uncertainty: 20 %<br>Reliability: H<br>Source: (2,1,2,3) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 0/1/M/+/L/L/L | |

### Table B- 2: Cover on zinc bath

| | | |
|---|---|---|
| Name of measure | Cover on zinc bath | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Thermal zincing | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 30 % | Uncertainty: [10 ,40]<br>Reliability: H<br>Source: (2,2,2,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 3. Reduction of heat losses through surfaces | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,20] |

| | | |
|---|---|---|
| | | Reliability: H<br>Source: (5,1,9,4) |
| Current penetration (1999) | 70 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 4 /(GJ/yr) | Uncertainty: 20 %<br>Reliability: H<br>Source: (1,2,3,3) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 0/0/M/+/L/L/L | |

**Table B- 3: Submerged gas burner (gas)**

| | | |
|---|---|---|
| Name of measure | Submerged gas burner (gas) | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Heating pre/posttreatment baths | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 50 % | Uncertainty: [30 ,70]<br>Reliability: H<br>Source: (2,1,2,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 3. Reduction of heat losses through surfaces | |
| First year of implementation | 1995 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,5]<br>Reliability: H<br>Source: (5,1,2,4) |
| Current penetration (1999) | | |
| Technical maximum penetration | 50 % | |
| Additional investments | € 25 /(GJ/yr) | Uncertainty: [10 ,40]<br>Reliability: H<br>Source: (2,1,3,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 1/1/S/0/L/L/M | |

**Table B- 4: Heat recovery for use in pretreatment bath (gas)**

| | | |
|---|---|---|
| Name of measure | Heat recovery for use in pretreatment bath (gas) | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Heating pre/posttreatment baths | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 80 % | Uncertainty: [40 ,100]<br>Reliability: H<br>Source: (1,2,2,4) |

| | | |
|---|---|---|
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 4. Heat recovery | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (1,2,2,4) |
| Current penetration (1999) | 2 % | |
| Technical maximum penetration | 14 % | |
| Additional investments | € 20 /(GJ/yr) | Uncertainty: 30 %<br>Reliability: M<br>Source: (1,2,3,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 0/0/S/0/M/M/L | |

**Table B- 5: Improved burner for zinc bath**

| | | |
|---|---|---|
| Name of measure | Improved burner for zinc bath | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Thermal zincing | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 30 % | Uncertainty: [10 ,40]<br>Reliability: M<br>Source: (6,0,0,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 11. More efficient furnaces and burners | |
| First year of implementation | 2000 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (5,0,0,4) |
| Current penetration (1999) | | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 0 /(GJ/yr) | Uncertainty:<br>Reliability: M<br>Source: (6,0,0,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 1/0/S/0/M/M/L | |

**Table B- 6: Spraying tunnels**

| | | |
|---|---|---|
| Name of measure | Spraying tunnels | |
| (sub)sector code | SBI 285 Coating of metals | |

| | | |
|---|---|---|
| Energy function | Heating pre/posttreatment baths | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 80 % | Uncertainty: [50 ,90]<br>Reliability: M<br>Source: (6,0,10,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 10. New process technologies | |
| First year of implementation | 2010 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,0,4) |
| Current penetration (1999) | | |
| Technical maximum penetration | 50 % | |
| Additional investments | € 0 /(GJ/yr) | Uncertainty: [0 ,20]<br>Reliability: M<br>Source: (6,0,10,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/1/S/+/M/M/M | |

### Table B- 7: Impr. of product logistics (pretreat; gas)

| | | |
|---|---|---|
| Name of measure | Impr. of product logistics (pretreat; gas) | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Heating pre/posttreatment baths | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 10 % | Uncertainty: [0 ,15]<br>Reliability: M<br>Source: (6,2,6,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 2. Process control and management | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,1,0) |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 15 /(GJ/yr) | Uncertainty: 30 %<br>Reliability: M<br>Source: (2,2,6,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |

| | | |
|---|---|---|
| Implementation Char | 0/0/S/+/M/M/L | |

**Table B- 8: Improvement of product logistics (zincing)**

| | | |
|---|---|---|
| Name of measure | Improvement of product logistics (zincing) | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Thermal zincing | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 10 % | Uncertainty: [0 ,15]<br>Reliability: M<br>Source: (2,2,6,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 2. Process control and management | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,1,0) |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 15 /(GJ/yr) | Uncertainty: 30 %<br>Reliability: M<br>Source: (2,2,6,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 0/0/S/+/M/M/L | |

**Table B- 9: Optimisation of muffle furnaces**

| | | |
|---|---|---|
| Name of measure | Optimisation of muffle furnaces | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Muffling | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 35 % | Uncertainty: [20 ,50]<br>Reliability: H<br>Source: (2,1,2,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 3. Reduction of heat losses through surfaces | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,1,0) |
| Current penetration (1999) | 10 % | |

| | | |
|---|---|---|
| Technical maximum penetration | 100 % | |
| Additional investments | € 9 /(GJ/yr) | Uncertainty: [3 ,15]<br>Reliability: M<br>Source: (2,1,3,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/ /S/0/M/L/L | |

**Table B- 10: Infra-red furnaces**

| | | |
|---|---|---|
| Name of measure | Infra-red furnaces | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Muffling | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 60 % | Uncertainty: [50 ,70]<br>Reliability: H<br>Source: (2,6,3,3) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 10. New process technologies | |
| First year of implementation | 2005 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,0,4) |
| Current penetration (1999) | | |
| Technical maximum penetration | 50 % | |
| Additional investments | € 0 /(GJ/yr) | Uncertainty: 10 %<br>Reliability: M<br>Source: (6,0,0,3) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/1/S/0/M/M/H | |

**Table B- 11: Low-bake coatings**

| | | |
|---|---|---|
| Name of measure | Low-bake coatings | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Muffling | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 50 % | Uncertainty: [30 ,70]<br>Reliability: L<br>Source: (6,0,10,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 10. New process technologies | |

| | | |
|---|---|---|
| First year of implementation | 2010 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: (0,0,0,0) |
| Current penetration (1999) | | |
| Technical maximum penetration | 75 % | |
| Additional investments | € 0 /(GJ/yr) | Uncertainty: 10 %<br>Reliability: M<br>Source: (6,0,0,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/1/M/0/H/L/M | |

**Table B- 12: Insulation and covers on process baths (electric)**

| | | |
|---|---|---|
| Name of measure | Insulation and covers on process baths (electric) | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Heating pre/posttreatment baths | |
| Savings electricity | 20 % | Uncertainty: [10 ,30]<br>Reliability: H<br>Source: (2,2,6,4) |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: (2,1,2,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 3. Reduction of heat losses through surfaces | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 10 % | Uncertainty: [0 ,20]<br>Reliability: H<br>Source: (5,1,2,4) |
| Current penetration (1999) | 70 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 2 /(GJ/yr) | Uncertainty: 20 %<br>Reliability: H<br>Source: (2,1,2,3) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 0/1/M/+/L/L/L | |

**Table B- 13: Submerged gas burner (electric)**

| | | |
|---|---|---|
| Name of measure | Submerged gas burner (electric) | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Heating pre/posttreatment baths | |
| Savings electricity | 100 % | Uncertainty: [100 ,100]<br>Reliability: H<br>Source: (6,0,1,0) |
| Savings fuel | 0 % | Uncertainty: |

| | | |
|---|---|---|
| | | Reliability:<br>Source: (0,0,0,0) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Extra energy (% of savings) | 110 % Natural gas | |
| Type of measure | Retrofit | |
| Measure category | 3. Reduction of heat losses through surfaces | |
| First year of implementation | 1995 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,5]<br>Reliability: H<br>Source: (5,1,2,4) |
| Current penetration (1999) | | |
| Technical maximum penetration | 50 % | |
| Additional investments | € 8 /(GJ/yr) | Uncertainty: [3 ,10]<br>Reliability: H<br>Source: (2,1,3,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 1/1/S/0/L/L/M | |

**Table B- 14: Heat recovery for use in pretreatment bath (el.)**

| | | |
|---|---|---|
| Name of measure | Heat recovery for use in pretreatment bath (el.) | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Heating pre/posttreatment baths | |
| Savings electricity | 80 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 0 % | Uncertainty: [40 ,100]<br>Reliability: H<br>Source: (1,2,2,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 4. Heat recovery | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (1,2,2,4) |
| Current penetration (1999) | 2 % | |
| Technical maximum penetration | 20 % | |
| Additional investments | € 8 /(GJ/yr) | Uncertainty: 30 %<br>Reliability: M<br>Source: (1,2,3,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 0/0/S/0/M/M/L | |

**Table B- 15: Impr. of product logistics (pretreat; electr.)**

| | | |
|---|---|---|
| Name of measure | Impr. of product logistics (pretreat; electr.) | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | Heating pre/posttreatment baths | |
| Savings electricity | 10 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 0 % | Uncertainty: [0 ,15]<br>Reliability: M<br>Source: (6,2,6,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 2. Process control and management | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,1,0) |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 6 /(GJ/yr) | Uncertainty: 30 %<br>Reliability: M<br>Source: (2,2,6,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 0/0/S/+/M/M/L | |

**Table B- 16: Monitoring and targeting**

| | | |
|---|---|---|
| Name of measure | Monitoring and targeting | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | All | |
| Savings electricity | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Good housekeeping | |
| Measure category | 1. Good Housekeeping | |
| First year of implementation | 1995 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 5 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |

| | | |
|---|---|---|
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/P/0/L/M/L | |

**Table B- 17: Monitoring and targeting 2010**

| | | |
|---|---|---|
| Name of measure | Monitoring and targeting 2010 | |
| (sub)sector code | SBI 285 Coating of metals | |
| Energy function | All | |
| Savings electricity | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Good housekeeping | |
| Measure category | 1. Good Housekeeping | |
| First year of implementation | 2010 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 3 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/P/0/L/M/L | |

# Steel containers and other metal products

### Table B- 18: Optimisation of muffle furnaces

| | | |
|---|---|---|
| Name of measure | Optimisation of muffle furnaces | |
| (sub)sector code | SBI 287 Steel containers and other metal products | |
| Energy function | Muffling | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 35 % | Uncertainty: [20 ,50]<br>Reliability: H<br>Source: (2,1,2,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 3. Reduction of heat losses through surfaces | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,1,0) |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 9 /(GJ/yr) | Uncertainty: [9 ,15]<br>Reliability: M<br>Source: (2,1,3,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/ /S/0/M/L/L | |

### Table B- 19: Monitoring and targeting

| | | |
|---|---|---|
| Name of measure | Monitoring and targeting | |
| (sub)sector code | SBI 287 Steel containers and other metal products | |
| Energy function | All | |
| Savings electricity | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Good housekeeping | |
| Measure category | 1. Good Housekeeping | |
| First year of implementation | 1995 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |

| | | |
|---|---|---|
| Technical maximum penetration | 100 % | |
| Additional investments | € 5 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/P/0/L/M/L | |

**Table B- 20: Monitoring and targeting 2010**

| | | |
|---|---|---|
| Name of measure | Monitoring and targeting 2010 | |
| (sub)sector code | SBI 287 Steel containers and other metal products | |
| Energy function | All | |
| Savings electricity | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Good housekeeping | |
| Measure category | 1. Good Housekeeping | |
| First year of implementation | 2010 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 3 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/P/0/L/M/L | |

## Lights and electronic equipment

### Table B- 21: Replacement of electric by gas furnaces

| | | |
|---|---|---|
| Name of measure | Replacement of electric by gas furnaces | |
| (sub)sector code | SBI 314-6,32 Lights and electronic equipment | |
| Energy function | Furnaces | |
| Savings electricity | 100 % | Uncertainty: [100 ,100]<br>Reliability: H<br>Source: (0,0,1,0) |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Extra energy (% of savings) | 110 % Natural gas | |
| Type of measure | New | |
| Measure category | 15. Fuel shift | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,1,0) |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 50 % | |
| Additional investments | € 4 /(GJ/yr) | Uncertainty:<br>Reliability: M<br>Source: (6,0,10,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/1/S/0/M/L/M | |

### Table B- 22: Tunnel instead of batch furnace (electric)

| | | |
|---|---|---|
| Name of measure | Tunnel instead of batch furnace (electric) | |
| (sub)sector code | SBI 314-6,32 Lights and electronic equipment | |
| Energy function | Furnaces | |
| Savings electricity | 100 % | Uncertainty: [100 ,100]<br>Reliability: H<br>Source: (0,0,1,0) |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Extra energy (% of savings) | 110 % Natural gas | |
| Type of measure | New | |
| Measure category | 11. More efficient furnaces and burners | |
| First year of implementation | 1990 | |

| | | |
|---|---|---|
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 5 % | |
| Technical maximum penetration | 20 % | |
| Additional investments | € 20 /(GJ/yr) | Uncertainty: 20 %<br>Reliability: M<br>Source: (2,2,3,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/0/S/+/M/L/M | |

**Table B- 23: Tunnel instead of batch furnace (gas)**

| | | |
|---|---|---|
| Name of measure | Tunnel instead of batch furnace (gas) | |
| (sub)sector code | SBI 314-6,32 Lights and electronic equipment | |
| Energy function | Furnaces | |
| Savings electricity | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (0,0,0,0) |
| Savings fuel | 30 % | Uncertainty: [20 ,60]<br>Reliability: M<br>Source: (2,2,6,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 11. More efficient furnaces and burners | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [5 ,15]<br>Reliability: M<br>Source: (6,0,10,4) |
| Current penetration (1999) | 5 % | |
| Technical maximum penetration | 20 % | |
| Additional investments | € 20 /(GJ/yr) | Uncertainty: 30 %<br>Reliability: M<br>Source: (2,2,6,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/0/S/+/M/L/M | |

**Table B- 24: Mini-environments in semiconductor manuf.**

| | | |
|---|---|---|
| Name of measure | Mini-environments in semiconductor manuf. | |
| (sub)sector code | SBI 314-6,32 Lights and electronic equipment | |
| Energy function | Clean room facilities | |
| Savings electricity | 30 % | Uncertainty: [15 ,45]<br>Reliability: M |

| | | |
|---|---|---|
| | | Source: (6,0,10,4) |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 2. Process control and management | |
| First year of implementation | 1995 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 50 % | |
| Additional investments | € 0 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 5 year | |
| Implementation Char | 1/1/S/+/M/L/L | |

**Table B- 25: Optimization of clean rooms (non-semicond.)**

| | | |
|---|---|---|
| Name of measure | Optimization of clean rooms (non-semicond.) | |
| (sub)sector code | SBI 314-6,32 Lights and electronic equipment | |
| Energy function | Clean room facilities | |
| Savings electricity | 30 % | Uncertainty: [10 ,50]<br>Reliability: L<br>Source: (6,0,0,4) |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 2. Process control and management | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 5 % | |
| Technical maximum penetration | 50 % | |
| Additional investments | € 5 /(GJ/yr) | Uncertainty: 30 %<br>Reliability: M<br>Source: (6,0,0,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/0/P/0/M/L/L | |

**Table B- 26: Heat recuperation from clean room air flow**

| | | |
|---|---|---|
| Name of measure | Heat recuperation from clean room air flow | |
| (sub)sector code | SBI 314-6,32 Lights and electronic equipment | |
| Energy function | Clean room facilities | |
| Savings electricity | 15 % | Uncertainty: [10 ,30]<br>Reliability: M<br>Source: (6,0,0,4) |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 4. Heat recovery | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 30 /(GJ/yr) | Uncertainty:<br>Reliability: M<br>Source: (6,0,0,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/0/M/0/M/M/L | |

**Table B- 27: Optimisation of furnaces (gas)**

| | | |
|---|---|---|
| Name of measure | Optimisation of furnaces (gas) | |
| (sub)sector code | SBI 314-6,32 Lights and electronic equipment | |
| Energy function | Furnaces | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 30 % | Uncertainty: [20 ,50]<br>Reliability: M<br>Source: (2,6,2,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 3. Reduction of heat losses through surfaces | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,1,0) |
| Current penetration (1999) | 10 % | |

| | | |
|---|---|---|
| Technical maximum penetration | 100 % | |
| Additional investments | € 9 /(GJ/yr) | Uncertainty: [3 ,15]<br>Reliability: M<br>Source: (2,6,3,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/ /S/0/M/L/L | |

**Table B- 28: Optimisation of furnaces (electr.)**

| | | |
|---|---|---|
| Name of measure | Optimisation of furnaces (electr.) | |
| (sub)sector code | SBI 314-6,32 Lights and electronic equipment | |
| Energy function | Furnaces | |
| Savings electricity | 20 % | Uncertainty: [10 ,30]<br>Reliability: M<br>Source: (6,7,0,4) |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: (0,0,0,0) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 3. Reduction of heat losses through surfaces | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,1,0) |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 4 /(GJ/yr) | Uncertainty: [1 ,6]<br>Reliability: M<br>Source: (6,7,3,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/ /S/0/M/L/L | |

**Table B- 29: Monitoring and targeting**

| | | |
|---|---|---|
| Name of measure | Monitoring and targeting | |
| (sub)sector code | SBI 314-6,32 Lights and electronic equipment | |
| Energy function | All | |
| Savings electricity | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 5 % | Uncertainty: |

| | | |
|---|---|---|
| | | Reliability:<br>Source: |
| Type of measure | Good housekeeping | |
| Measure category | 1. Good Housekeeping | |
| First year of implementation | 1995 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 5 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/P/0/L/M/L | |

**Table B- 30: Monitoring and targeting 2010**

| | | |
|---|---|---|
| Name of measure | Monitoring and targeting 2010 | |
| (sub)sector code | SBI 314-6,32 Lights and electronic equipment | |
| Energy function | All | |
| Savings electricity | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Good housekeeping | |
| Measure category | 1. Good Housekeeping | |
| First year of implementation | 2010 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 3 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/P/0/L/M/L | |

## Automobiles

### Table B- 31: High efficiency motors and VSD's

| | | |
|---|---|---|
| Name of measure | High efficiency motors and VSD's | |
| (sub)sector code | SBI 341 Automobiles | |
| Energy function | Electric drives | |
| Savings electricity | 10 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 9. More efficient conversion of electricity into movement | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 5 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 30 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/S/0/M/L/L | |

### Table B- 32: Optimisation of compressed air supply

| | | |
|---|---|---|
| Name of measure | Optimisation of compressed air supply | |
| (sub)sector code | SBI 341 Automobiles | |
| Energy function | Compressed air | |
| Savings electricity | 15 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 2. Process control and management | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |

| | | |
|---|---|---|
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 5 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/0/M/0/L/M/L | |

**Table B- 33: Optimisation of muffle furnaces**

| | | |
|---|---|---|
| Name of measure | Optimisation of muffle furnaces | |
| (sub)sector code | SBI 341 Automobiles | |
| Energy function | Muffle furnaces | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 35 % | Uncertainty: [20 ,50]<br>Reliability: H<br>Source: (2,1,2,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 3. Reduction of heat losses through surfaces | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,1,0) |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 9 /(GJ/yr) | Uncertainty: [3 ,15]<br>Reliability: M<br>Source: (2,1,3,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/ /S/0/M/L/L | |

**Table B- 34: Optimisation of other furnaces (gas)**

| | | |
|---|---|---|
| Name of measure | Optimisation of other furnaces (gas) | |
| (sub)sector code | SBI 341 Automobiles | |
| Energy function | Other furnaces | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 30 % | Uncertainty: [20 ,50]<br>Reliability: M<br>Source: (2,6,2,4) |
| Savings heat | 0 % | Uncertainty:<br>Reliability: |

| | | |
|---|---|---|
| | | Source: |
| Type of measure | New | |
| Measure category | 3. Reduction of heat losses through surfaces | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,1,0) |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 9 /(GJ/yr) | Uncertainty: [3 ,15]<br>Reliability: M<br>Source: (2,6,3,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/ /S/0/M/L/L | |

**Table B- 35: Optimisation of other furnaces (electr.)**

| | | |
|---|---|---|
| Name of measure | Optimisation of other furnaces (electr.) | |
| (sub)sector code | SBI 341 Automobiles | |
| Energy function | Other furnaces | |
| Savings electricity | 20 % | Uncertainty: [10 ,30]<br>Reliability: M<br>Source: (6,7,0,4) |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: (0,0,0,0) |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 3. Reduction of heat losses through surfaces | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,1,0) |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 4 /(GJ/yr) | Uncertainty: [1 ,6]<br>Reliability: M<br>Source: (6,7,3,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/ /S/0/M/L/L | |

**Table B- 36: Replacement of electric by gas furnaces**

| | | |
|---|---|---|
| Name of measure | Replacement of electric by gas furnaces | |
| (sub)sector code | SBI 341 Automobiles | |

| | | |
|---|---|---|
| Energy function | Other furnaces | |
| Savings electricity | 100 % | Uncertainty: [100 ,100]<br>Reliability: H<br>Source: (0,0,1,0) |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Extra energy (% of savings) | 110 % Natural gas | |
| Type of measure | New | |
| Measure category | 15. Fuel shift | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty: [0 ,0]<br>Reliability: H<br>Source: (6,0,1,0) |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 75 % | |
| Additional investments | € 4 /(GJ/yr) | Uncertainty:<br>Reliability: M<br>Source: (6,0,10,4) |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 1/1/S/0/M/L/M | |

**Table B- 37: Monitoring and targeting**

| | | |
|---|---|---|
| Name of measure | Monitoring and targeting | |
| (sub)sector code | SBI 341 Automobiles | |
| Energy function | All | |
| Savings electricity | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Good housekeeping | |
| Measure category | 1. Good Housekeeping | |
| First year of implementation | 1995 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 5 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/P/0/L/M/L | |

**Table B- 38: Monitoring and targeting 2010**

| | | |
|---|---|---|
| Name of measure | Monitoring and targeting 2010 | |
| (sub)sector code | SBI 341 Automobiles | |
| Energy function | All | |
| Savings electricity | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Good housekeeping | |
| Measure category | 1. Good Housekeeping | |
| First year of implementation | 2010 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 3 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/P/0/L/M/L | |

**Table B- 39: High efficiency motors and VSD's**

| | | |
|---|---|---|
| Name of measure | High efficiency motors and VSD's | |
| (sub)sector code | SBI 341 Automobiles | |
| Energy function | Electric drives | |
| Savings electricity | 10 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 9. More efficient conversion of electricity into movement | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 5 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 30 /(GJ/yr) | Uncertainty:<br>Reliability: |

| | | |
|---|---|---|
| | | Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/S/0/M/L/L | |

**Table B- 40: Optimisation of compressed air supply**

| | | |
|---|---|---|
| Name of measure | Optimisation of compressed air supply | |
| (sub)sector code | SBI 341 Automobiles | |
| Energy function | Compressed air | |
| Savings electricity | 15 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 2. Process control and management | |
| First year of implementation | 1995 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 5 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/0/M/0/L/M/L | |

# Other metal-electro

*N.B.: The data below on measures related to space heating, ventilation and lighting are provisional and may be updated at a later date.*

**Table B- 41: Optimisation of air conditioners**

| | | |
|---|---|---|
| Name of measure | Optimisation of air conditioners | |
| (sub)sector code | SBI 281-284,286,29,30,311-312,342-3,35 Other metal-electro | |
| Energy function | Ventilation and airco | |
| Savings electricity | 10 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 2. Process control and management | |
| First year of implementation | 1995 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 5 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/0/M/0/L/M/L | |

**Table B- 42: Building insulation and ventilation heat recovery**

| | | |
|---|---|---|
| Name of measure | Building insulation and ventilation heat recovery | |
| (sub)sector code | SBI 281-284,286,29,30,311-312,342-3,35 Other metal-electro | |
| Energy function | Space heating | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 15 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 15 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 3. Reduction of heat losses | |

| | | |
|---|---|---|
| | through surfaces | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 25 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 0/0/P/0/M/L/L | |

**Table B- 43: Compartmentalisation and local ventilation**

| | | |
|---|---|---|
| Name of measure | Compartmentalisation and local ventilation | |
| (sub)sector code | SBI 281-284,286,29,30,311-312,342-3,35 Other metal-electro | |
| Energy function | Ventilation and airco | |
| Savings electricity | 10 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 2. Process control and management | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 70 % | |
| Additional investments | € 25 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 0/1/S/+/M/L/L | |

**Table B- 44: Additional insulation + building optimizer**

| | | |
|---|---|---|
| Name of measure | Additional insulation + building optimizer | |
| (sub)sector code | SBI 281-284,286,29,30,311-312,342-3,35 Other metal- | |

| | | |
|---|---|---|
| | electro | |
| Energy function | Space heating | |
| Savings electricity | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 20 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 20 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 3. Reduction of heat losses through surfaces | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 70 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 20 year | |
| Implementation Char | 0/1/P/0/L/L/L | |

**Table B- 45: Lighting control**

| | | |
|---|---|---|
| Name of measure | Lighting control | |
| (sub)sector code | SBI 281-284,286,29,30,311-312,342-3,35 Other metal-electro | |
| Energy function | Lighting | |
| Savings electricity | 50 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 2. Process control and management | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 20 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty: |

| | | |
|---|---|---|
| | | Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/P/0/L/M/L | |

**Table B- 46: HF ballasts for fluorescent lights**

| | | |
|---|---|---|
| Name of measure | HF ballasts for fluorescent lights | |
| (sub)sector code | SBI 281-284,286,29,30,311-312,342-3,35 Other metal-electro | |
| Energy function | Lighting | |
| Savings electricity | 20 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 7. Improved lighting | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 20 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/P/+/L/L/L | |

**Table B- 47: Optimisation of compressed air supply**

| | | |
|---|---|---|
| Name of measure | Optimisation of compressed air supply | |
| (sub)sector code | SBI 281-284,286,29,30,311-312,342-3,35 Other metal-electro | |
| Energy function | Compressed air | |
| Savings electricity | 15 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Retrofit | |
| Measure category | 2. Process control and | |

| | | |
|---|---|---|
| | management | |
| First year of implementation | 1995 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 5 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/0/M/0/L/M/L | |

**Table B- 48: High efficiency motors and VSD's**

| | | |
|---|---|---|
| Name of measure | High efficiency motors and VSD's | |
| (sub)sector code | SBI 281-284,286,29,30,311-312,342-3,35 Other metal-electro | |
| Energy function | Electric drives | |
| Savings electricity | 10 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | New | |
| Measure category | 9. More efficient conversion of electricity into movement | |
| First year of implementation | 1990 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 5 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 30 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/S/0/M/L/L | |

**Table B- 49: Monitoring and targeting 2010**

| | | |
|---|---|---|
| Name of measure | Monitoring and targeting 2010 | |
| (sub)sector code | SBI 281-284,286,29,30,311-312,342-3,35 Other metal-electro | |

| | | |
|---|---|---|
| Energy function | All | |
| Savings electricity | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 8 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Good housekeeping | |
| Measure category | 1. Good Housekeeping | |
| First year of implementation | 2010 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 3 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |
| Implementation Char | 0/1/P/0/L/M/L | |

**Table B- 50: Monitoring and targeting**

| | | |
|---|---|---|
| Name of measure | Monitoring and targeting | |
| (sub)sector code | SBI 281-284,286,29,30,311-312,342-3,35 Other metal-electro | |
| Energy function | All | |
| Savings electricity | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings fuel | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Savings heat | 5 % | Uncertainty:<br>Reliability:<br>Source: |
| Type of measure | Good housekeeping | |
| Measure category | 1. Good Housekeeping | |
| First year of implementation | 1995 | |
| Penetration base year (1995) | 0 % | Uncertainty:<br>Reliability:<br>Source: |
| Current penetration (1999) | 10 % | |
| Technical maximum penetration | 100 % | |
| Additional investments | € 5 /(GJ/yr) | Uncertainty:<br>Reliability:<br>Source: |
| Additional O&M costs | € 0 /GJ | Uncertainty:<br>Reliability:<br>Source: |
| Economic lifetime | 10 year | |

| | | |
|---|---|---|
| Implementation Char | 0/1/P/0/L/M/L | |