

Profitable investments in Environmental management System at ABB Motors AB (for abstract No 98)

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ABB has decided to implement EMS ISO 14001 at all of its manufacturing sites – a target that now is fulfilled to 97%. Since then the units have been working with continual improvements of its environmental results. A good example of such a successful implementation is The Machines Division of ABB Motors that was one of the first units in Sweden to be certified. This work resulted in a certificate in 1997-02-27.

The implementation of the environmental management system ISO 14001 resulted in an investment of approximately 4,9 million SEK for this unit of 300 employees. The result of these efforts indicated lower environmental impact as well as a better financial position. Reduced energy consumption and reduced utilization of chemicals are two good examples of activities that have provided both environmental and economical profit. Approx. 6,8 millions SEK was saved in one year meaning a Pay Back of investment of less than One year.

The article treats the project work such as formation of project group, evaluation principles, environmental flow charts etc and general principles of the total implementation phase.

The article also describes the process of continual improvements 1997 – 2000. Here it may be observed a reduction of consumption of electrical energy of 57% and district heating of 47% in 5 years. The emissions to air has been reduced with 56% during the same time. All this is presented with illustrative diagrams and pictures from successful investments.

1) Background

During the last years an increased amount of attention has been put upon environmental matters. This is fundamental for making it possible for mankind to survive with good life quality in long term.

As a result of this conscience it has been issued laws and has been put claims of the society and Industrial enterprises. More and more organizations have also started to claim that their suppliers have to work in an environmental correct way. This also is a matter of survival for

Industrial enterprises. ABBs group management became very early aware of these matters.

During a speech in the Norwegian City Stavanger in September 1995 the ABB President Percy Barnevik claimed that **Ecoefficiency** is the matter to be adapted by the companies in the ABB group. It then was decided that all the companies had to implement environmental management system ISO 14001. This became the start up for intense environmental activities within the different organizations within the group. Totally the ABB group consisted at this time of approximately 1000 different companies - with a total personnel of 215 000 employees.

The machines Division became a Pilot Unit in the city of Västerås, Sweden for this work. The target was to have the certificate within one year from the start up of this project.

2) Project Organization

M. Sc. Anders Allander was appointed project leader for these ambitious plans for the Machines Division. He explains the following :

"We started the job in January 1996 by making up plans for the activities to come and to join some courses concerning the environmental management system. We made a brief summing up of the environmental matters that concerned the Machines Division and had a first presentation for the Management team in February. As the presentation proceeded and more interesting facts were put upon the table the management team became as more enthusiastic. This resulted in lively discussions. It then was decided that the Machines Division was to be the first organization in Västerås to obtain its environmental certificate. We were thereafter to serve as a good example for other companies within the group.

I was appointed project leader and got myself a project group consisting of 3 project members **Åsa Sjögren, Bengt Lindh and Jörgen Dahl**. Besides this the whole management group including some central persons within the company (Michael Zeeck) and with in ABB in Sweden (Marja Widell) were appointed as Management group for the project. Besides this it was appointed 10 persons within the organization as reference persons for making some investigations and leaving information to the project group.

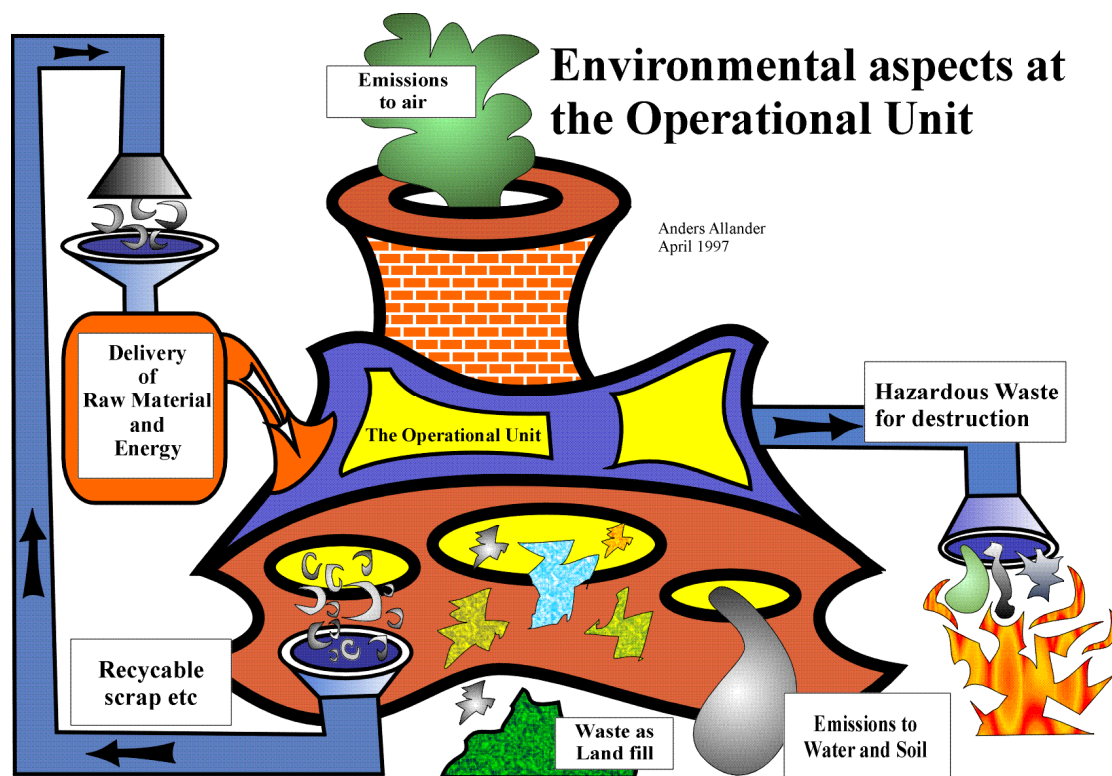
3) Analysis of present stage of the organization

The first phase of the project was to make an analysis of the present situation of the Machines Division concerning its environmental work. It

is here to be observed that this investigation only concerned external environmental matters. The internal environmental matters such as workers safety etc were excluded from the project. These last matters are managed by a separate regulation not to be included in the project. The Machines Division is a typical complete heavy industry with a lot of activities that gives impact upon the external environment. Among these activities it is to be mentioned: emissions to air and water, large energy consumption, utilization of large amounts of raw material, handling of hazardous waste and large transport volumes etc...etc...

The Machines Division manufactures electrical machines up to a size of 80 tons/piece. The personnel consist of 300 employees.

The following picture that also was used during the education of management and personnel may symbolize the Environmental Impact.



The picture shows the split up of environmental aspects in utilization of natural resources raw material and energy and also emissions of chemicals to air and water and soil. It also is shown generation of disposals. The hazardous waste is sent to a destruction company where it is taken care of by a little devil that burns it and destructs it making it safe to handle.

Anders Allander explains further :

”The chemicals that we have emitted comes mainly from impregnation processes for electrical windings and from painting plants. We have emitted approximately 13 tons during 1995. In large amounts this may cause the cereals and vegetables to oxidize and being destroyed. It also influences upon health of man. The division's emissions are not to be considered large but have in any case to be kept under control on a still lower level.

The raw material copper is a main component in electrical conductors and is consumed in large quantities during the manufacturing of electrical machines. Copper exists in a very limited amount in Nature and causes great environmental impact during the mining and the refining. Totally we consume more than 600 tons/year. As an example it may be pointed out that Boliden in Sweden need to refine 250 tons ore for each ton copper to be produced.

The environmental impact is among other matters depletion of natural resources and energy consumption and emissions of ashes and chemicals to air during the refining.”

Besides this it was analyzed the environmental aspects for products and for suppliers.

4) Evaluation of Environmental aspects

When the mapping of the present situation was finalized it was performed an evaluation of the significant environmental aspects by utilizing environmental impact points from the tools of life cycle assessments LCA. These impact points are international values that have been calculated by no-political experts of environmental impact for different environmental aspects. By using this objective tool it was observed that the division has the following significant environmental aspects.

- Disposal for land fill (Amount 210 tons/year)
- Consumption of raw material copper (Amount 600 tons/year)
- Consumption of electrical energy (Amount 13 000 MWh/year)
- Consumption for heat energy (Amount 8 000 MWh/year)
- Emissions of chemicals to air (Amount 13 tons/year)
- Transports (Amount 2 000 000 TonKm/year)

These quantified figures were transformed to environmental impact points/year. The higher points - the higher environmental impact. One matter that was observed was that the consumption of raw material copper had the utmost significant impact of all environmental aspects. The impact point was approximately ten times as high as the nearest other environmental impact - heat energy. Intense activities have been started up in order to reduce these amounts.

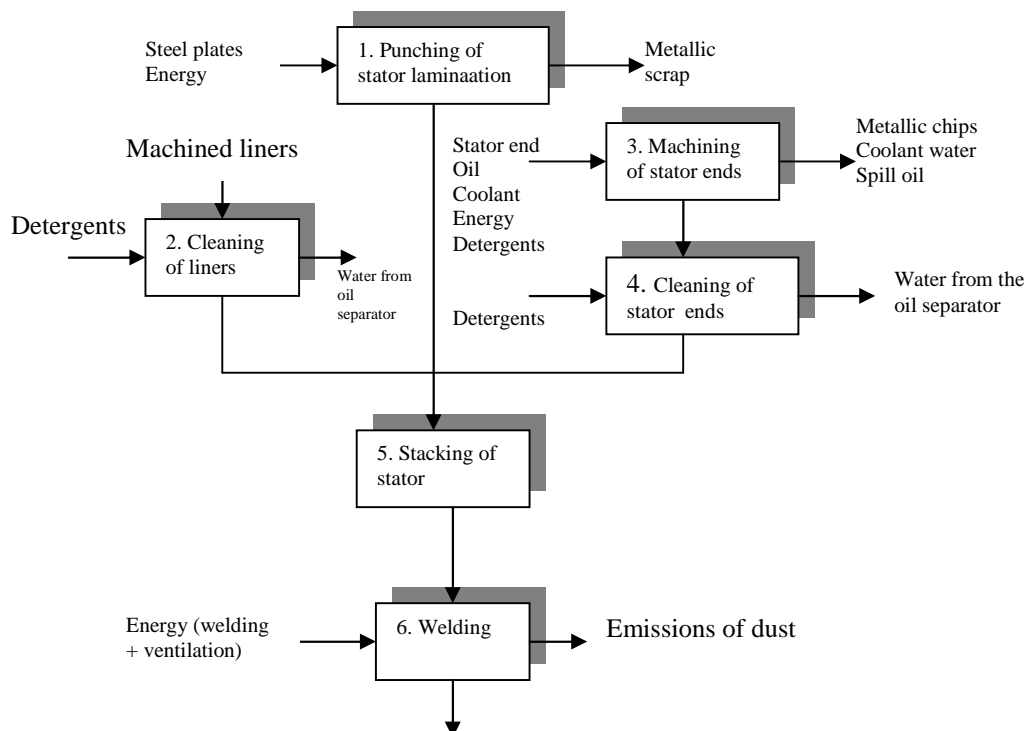
Besides this it was observed that due to demands from the authorities some emissions to water also were to be considered as significant ones.

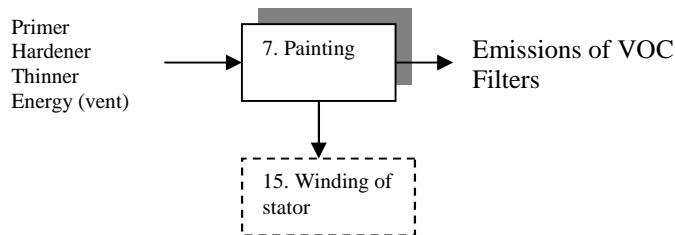
For these significant environmental aspects it was issued targets and action programs in order to fulfil the targets. This was a heavy job as the targets were made up until year 2000 - this means programs for five years. A detailed action program was made up for each year for each one of the significant environmental aspects.

5) Environmental flow charts

The mapping of the present environmental situation was performed together with groups of personnel in the workshop and the office, which made it more easy for the later coming implementation phase. Everything was well documented in so called environmental flow charts, which were completed with tables with information about present environmental aspects with quantified values for each station.

Such a flow chart is demonstrated below:





A table with the environmental aspects quantified is shown in following table. The example is only one out of several pages that show one of the products of the Machines Division. However it serves as a good example of what such a flow chart may look like.

Activity		Analyse of inflow				Analyse of outflow				
		Type of Resource	Amount raw materials tons/year	Energy-consumption MWh/year	Chemicals kg/year	Type of Disposal	Metallic scrap recycled tons/year	Land fill not recycled tons/year	Hazardous waste kg/year	Emissions kg/year
1	Punching	Steel plates	1356							
		El energy		44						
2	Cleaning of liners	Detergents			see 4	Water from oil separator			see 4	
3	Machining of stator ends	Stator end	173			Metallic chips	21			
		Coolant water			180	Coolant + water			1707	
		Oil			278	Spill oil			278	
		Energy		2						
		Detergents			31					
4	Cleaning of stator ends	Antioxidants			25	Water from oil separator			1198	
5	Stacking	Energy		39						
6	Painting	Primer			615	VOC from paint				141
		Hardener			513	VOC from hardener				164
		Thinner			500	VOC from thinner				500
		Energy (vent)		77						

This is a final summing up of the mapping of the present environmental situation of the Machines Division. It shows the utilization of natural resources as a group of environmental aspects coming in to each station - the in-flow. It also is completed with disposal and emissions as an out-flow from each station. The environmental aspects are quantified in figures in the enclosed table. The example demonstrates fictive figures but the principles may be adapted for each unique situation for other organizations.

6) Targets and action programs

Anders Allander continues.

”We decided very tough targets for the different environmental targets. For electrical energy we have planned a reduction of 50% and for heat energy for the building we have decided 45%. The amounts of copper are much more difficult to reduce, as we for the function of our products (machines) need a certain amount of copper. However here it exists partial projects for reduction of margins, for recycling and also for amount of copper in our products. For the emissions of air we had as a target a reduction of 70% to year 2000. All the targets are now fulfilled and we have decided new more tough targets for the future. Some

investments may be necessary to perform in order to fulfil the programs and to reach all of the targets.

7) Implementation

A very important work was to implement the environmental management system in practice within the organization. For this purpose it was started up some educational programs with among others the project member Åsa Sjögren as a teacher. We issued a lot of selling pictures to make these matters to penetrate through the organization. These pictures are partially described in this article according to some examples. All were adapted with great enthusiasm.

Besides this it was also performed some investments in process equipment and equipment for waste management.

It showed up that the result of the environmental efforts went surprising well. Both the amount of disposals and the emissions were reduced in a most radical way. As an example it may be mentioned that everybody started to be much more restrictive in utilizing solvents and detergents making it possible to reduce the consumption of chemicals and also the emissions of VOC to air in a most radical way.

8) Documentation

A large work was to issue documentation in form of instructions, environmental descriptions and workshop handbooks for the personnel in the workshop. This documentation went very extent and included 400 pages of text.

But as a result it went much more structured in an useful way. Each operator have available a handbook in environmental matters that are valid for his unique place of work.

9) Auditing and Certification

Anders Allander continues :

”In December 1996 we were visited by a group of auditors from the certification body SIS (now it belongs to DNV) in order the be studied in detail. They used some days for penetration of the organization and found out a lot of non-conformities. The largest problem was that we had not sufficient knowledge of the environmental laws and how to adapt these upon the organization. This became an important remark

We learned some lessons and had to make corrections during a couple of months before the next visit by the auditors. Now it went much better. After some smaller adjustments we received our certificate - with date 1997-02-21.

It all was celebrated with a lot of cakes for the personnel. As a symbol for the environmental work a logotype was made up demonstrating a combined energy- and recycling symbol. This symbol was printed out upon each cake.



The same symbol also was printed out upon a lot of stickers that thereafter are attached upon all correspondence leaving the Machines Division, pointing out the successful environmental performance of the Machines Division.

10) Result of the environmental activities

It is observed that after having installed a well working Environmental Management system already after one year a radical reduction of the environmental impact is obtained. And this tendency goes on year after year. In the following are showed some results from the 3-4 years after the certification. A comparison from previous years is also demonstrated in the diagrams below.

10.1) General about environmental aspects

For the Machines division it is selected the following significant environmental aspects :

Examples of significant environmental aspects :

- **Landfill waste**
- **Raw material copper**
- **Consumption of electrical energy**
- **Consumption of heat energy**
- **Emissions to air**
- **Emissions to water**
- **Transports**

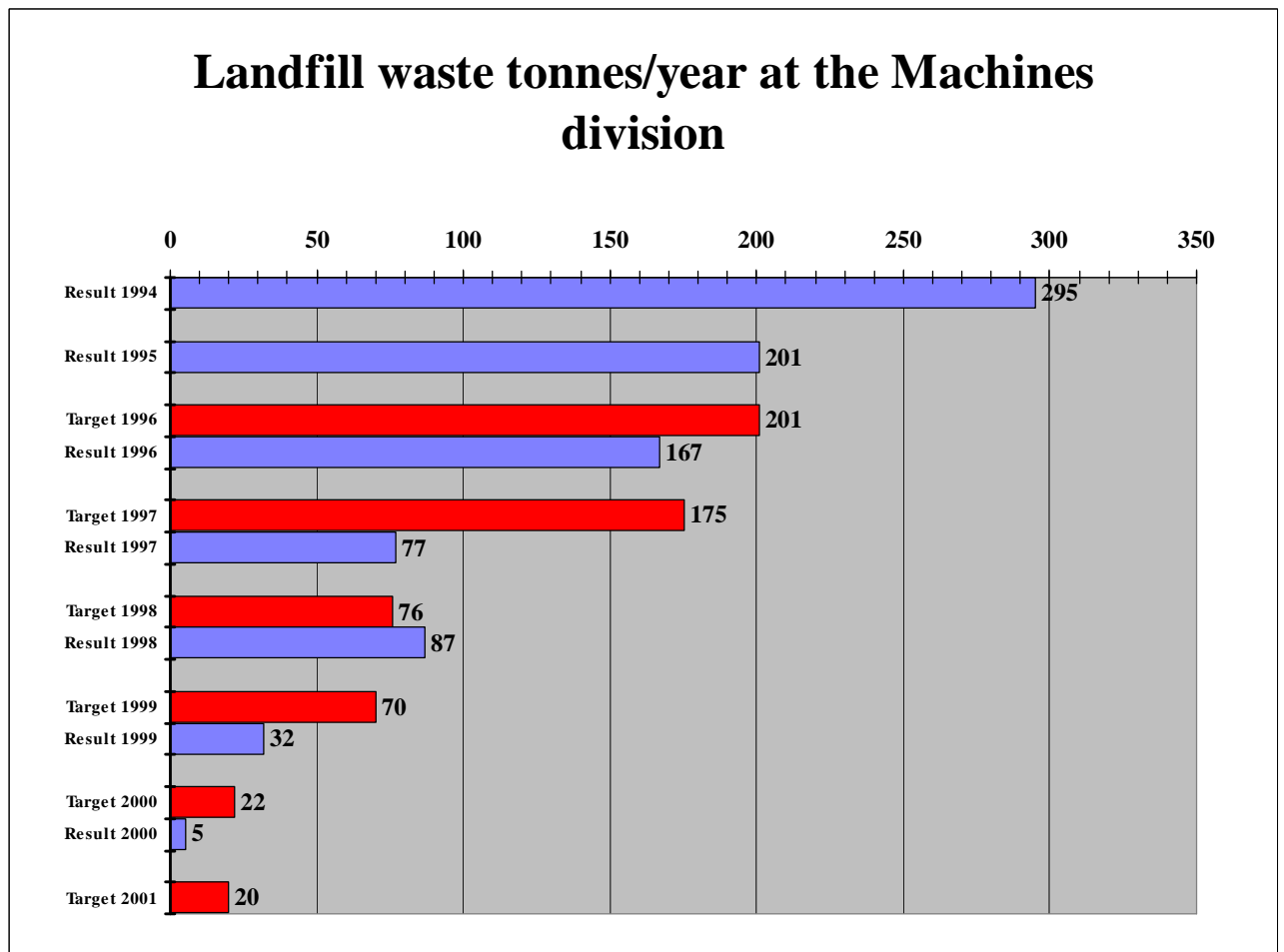
For each one of these (excluding Transports) it is set targets and issued action plans that to some extent already are fulfilled.

The first targets were set without deep knowledge of real potentials and were in many cases based upon pure estimations. Among this it may be mentioned the amounts of landfill waste. It is in these cases not considered that the implementation of the environmental management system as such has created a much more positive development that was previously possible to calculate. It was demonstrated that in many cases the reductions were much larger. This has to do with that the personnel has showed great enthusiasm for the environmental issues and done their utmost to use natural resources more restrictive.

Below it is demonstrated some examples from the Motor Division of Environmental Production AB. These are achieved results. The potentials are demonstrated in clause 5 previously.

10.2) Continual improvements of landfill waste

Following table may be studied. It shows the result year by year.



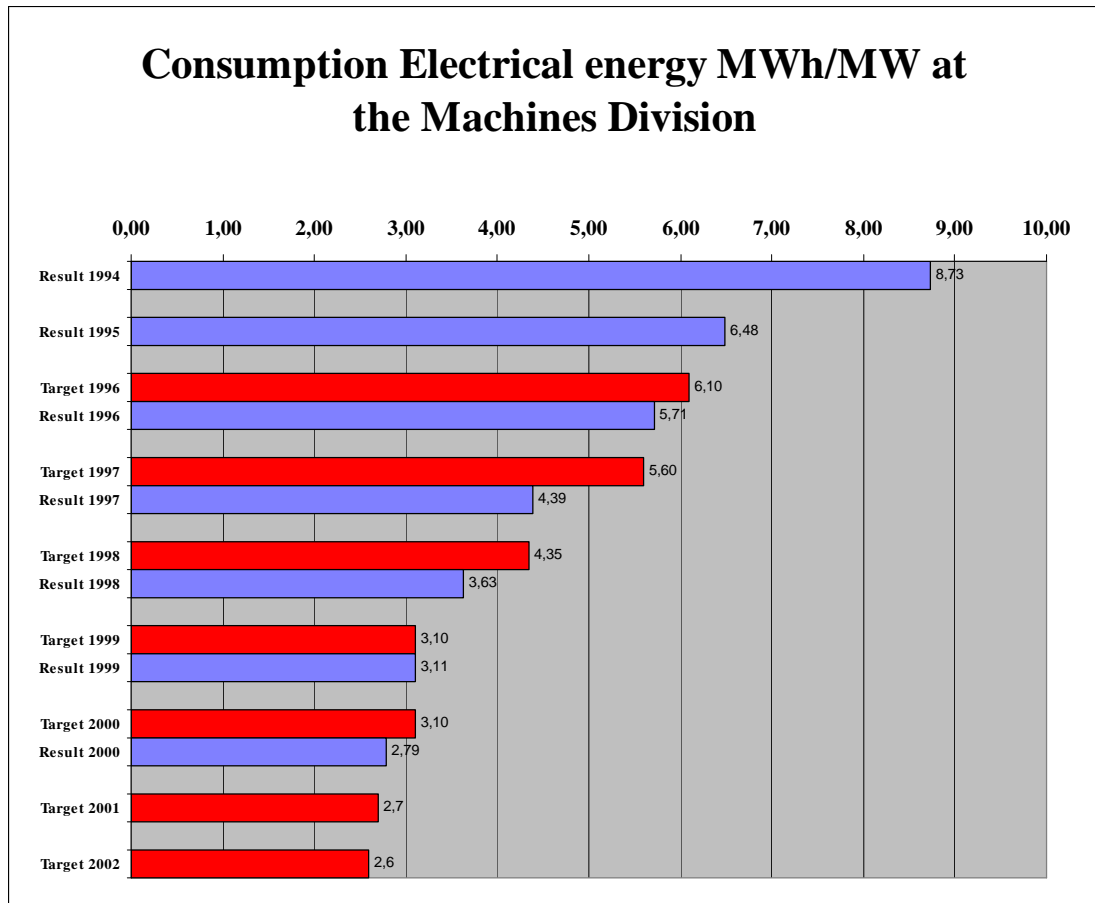


One of the reasons for reductions of Landfill waste was installation of briquette presses. These presses press cardboard paper to briquettes making them much easier to handle. Instead of having to pay to get rid of the cardboard paper as landfill waste it is now a valuable raw material for the paper industry that the division gets payed for.

Using of briquette presses resulted in that many operators now thought it to be fun to recycle. This resulted in that now it is very little cardboard papers that are put as landfill waste. The recycling of cardboard paper resulted in a reduction of landfill waste of 15 tons/year.

10.3) Continual improvements Consumption of electrical energy

Following table may be studied. It shows the result year by year.



It is also here observed better reductions than the targets. The target for 1996 was set to 6,10 MWh/MW delivered products. The result was 5,71. The same tendency was going on during 1997 when it was achieved 4,39.

It is observed a rurther eduction during 1997 2000

Below it is demonstrated some examples of what was done in order to obtain these reductions.

Example 1 for reduction of electrical energy

Control of process water pump

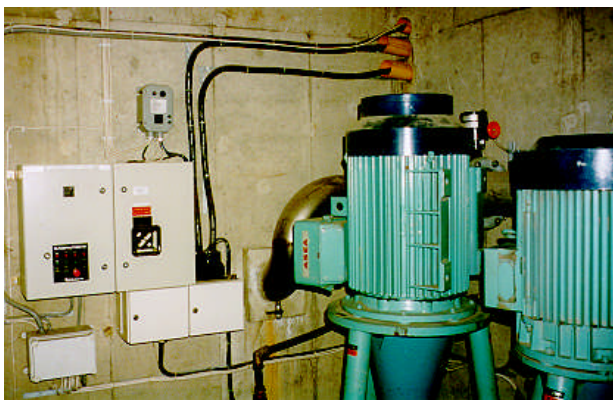
Description

Within the workshop of the Motor Division there are a system for circulating cooling water from a fire dam. This cooling water is among others used for cooling of electrical machines during the testing in the test room. Using circulating water from a fire dam is a good environmental solution as such. The water is after the use returning to the fire dam causing theoretically no consumption of fresh water.

However the process pumps for this circulating of water required a high consumption of electrical energy. They were running 24 hours/day during 365 days/year. This caused an annual need of electricity 350 MWh/year.

Taken action. **The pumps were provided with timer and manual control in order to be able to switch off the pumps when circulating water was not needed. They were switched off during night and at the weekends.**

Result. The consumption of electrical energy was reduced by 250 MWh/year which means a saving of 100 KSEK/year at an investment of 60 KSEK which means a Pay Back of 0,6 year.



Picture 10.3-1. Control of process water pumps located in a pit some hundred meters from the workshop. Electrical cables leads to the workshop.



Picture 10.3-2 : Control device in the workshop making it possible to switch off or on the pumps manually or automatically.

Example 2 for reduction of electrical energy

Control of process ventilation

Description. In the building of the workshop of the Motor Division there are a lot of devices for extraction of air. It was installed process ventilation. They are needed in order to reduce the amount of dust or solvents in the surroundings of the operators. It is essential from workers protection point of view. Manual switches having 2 positions controlled these devices and extraction fans: on or off. The discipline was rather bad concerning to switch the process ventilation off when they were not needed for production. 20 of these extractors were modified which meant a radical reduction of consumption of energy.

Taken action. The devices were provided with timers that switched the process ventilation off after having running some time after the utilization or after the end of the day.

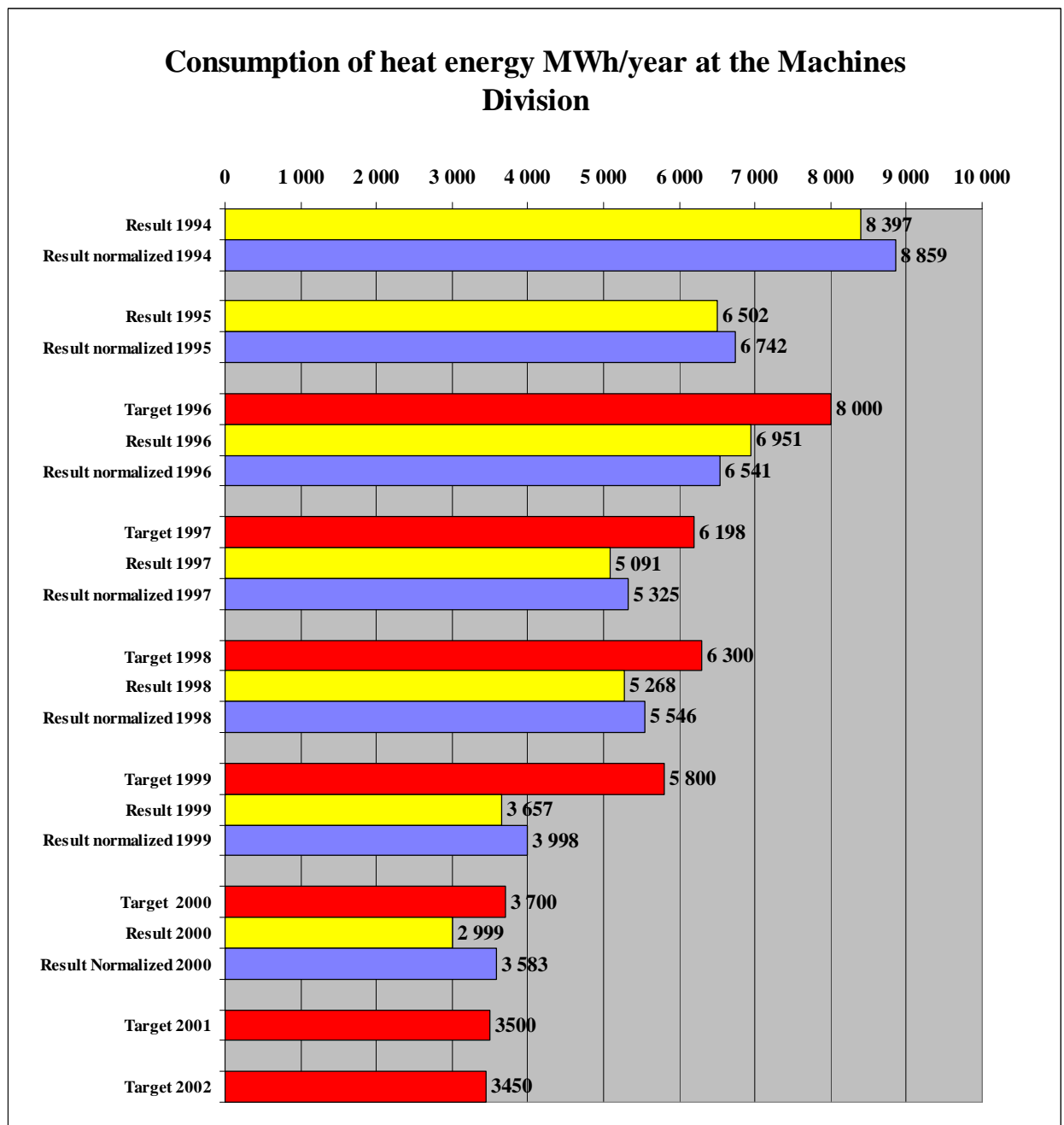
Result. The consumption of electrical energy was reduced by 280 MWh/year, which means a saving of 120 KSEK/year. Also the consumption of district heat was reduced due to less air to heat as the extraction and inlet of air was reduced. A reduced extraction and inlet of air means less air to heat to room temperature. This reduction became 350 MWh/year, which means an additional saving of 100 KSEK/year. At an investment of 90 KSEK this means a Pay Back of 0,4 year.



Picture 10.3-3. Extraction fans and equipment for general ventilation or inlet of air on the roof of the workshop. The fans for extraction are showed at the right in end side of the roof.

10.4) Continual improvements Consumption of heat energy

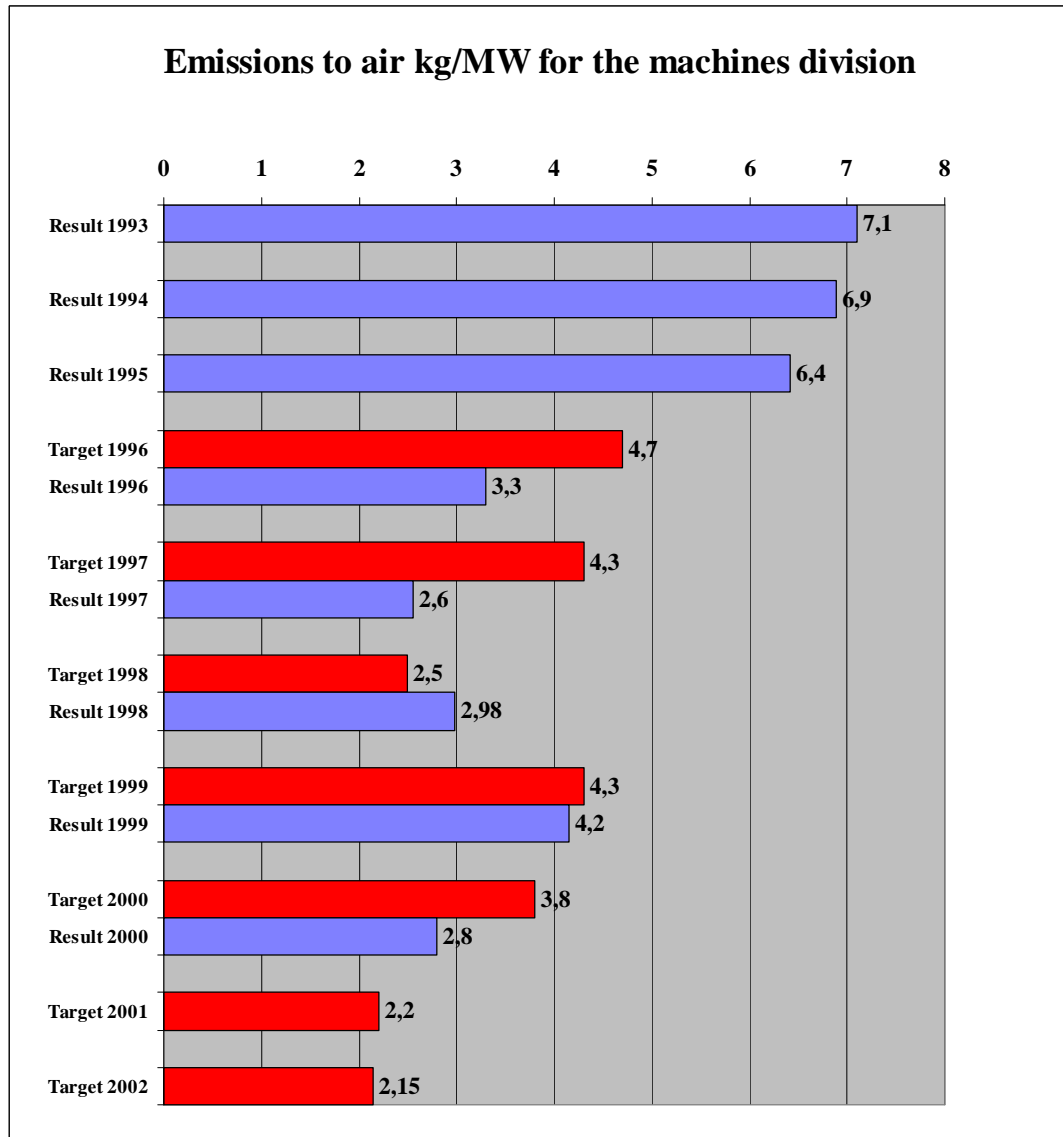
Following table may be studied. It shows the result year by year.



It shows a reduction from 8 859 to 3 583 MWh during the last 5 years for coal based district heating.

10.5) Continual improvements for reductions of emissions to air

Following table may be studied. It shows the result year by year.



Here it is to be observed that the target for 1996 was an emission of VOC to air 4,7 Kg/MW while the result became the surprising low 3,3 kg VOC/MW. This important reduction was mainly due to that it had not been possible to calculate the effect of that the personnel became much more restrictive in using solvents for the productions. The unnecessary waste was eliminated.

Another factor was that it during the year was started up a new process using chemically curing resin instead of solvent—based varnish in a new impregnation plant for product B. This reduced the emissions with 2 tons/year.

Below it is demonstrated some examples of how the emissions to air have been reduced during 1995-1999.



Solvent waste and paint waste is collected in a barrel provided with a funnel. Earlier that kind of waste was poured out into the barrier water pool of the paint box, where it was evaporating.

Here a further improvement has been performed. The funnel has been provided with a tap reducing the emissions even more.

As the contents of the barrel is hazardous concerning fire the barrel also has been provided with an electrical connection to earth – a simple cable!

With this simple device the emissions to air have been reduced with 2400 kg VOC/year with very limited investments for the organization with 300 employees.



It is installed a new impregnation plant for product B. In this plant it is used chemically curing resin instead of solvent based varnish.

This has resulted in reduced emissions of solvents 2000 kg/year.

Implementation of a system with non-volatile resin is going on resulting in a further reduction of 2000-2500 kg/year. So far this results in less emissions to air of 30% of the whole operation of the division.

Besides these advantages the plant also has resulted in important savings of electrical energy and heat energy. See further these chapters.



Another continual improvement of more general character is that the metallic scrap now is separated in 17 different fractions. It is collected in small containers in the workshop. Truck drivers thereafter empty these containers in larger containers placed outside the workshop. The picture above shows some of these large containers inspected by the property operator.

In the picture it also is shown a possibility of improvements. The scrap containers ought to be located under a roof. This has to be done to avoid rainwater to come into the containers causing corrosion of the contents or the containers.

The same system is used also for other types of recyclable waste such as paper, cardboard paper, wood, soft plastics, combustible waste etc.

Another part of the continual improvements is the information to the personnel. A special board with information of environmental issues is updated each 3 months where news and current results are presented. Such a board may look like below.



Here the same pictures as are used in the education of the personnel are used. This together with the result of the environmental efforts including the action plans.

It is advertised in the personnel newsletter that new diagrams and pictures are issued. There it also is given comments to the result. Also the computerized Intranet is used for environmental information.

All these ways are important sources of information. They have influenced in a very positive way to the very good environmental result obtained by the organization.

11) Economy matters

An important argument for implementing an environmental management system is that it in reality is possible to gain a lot of money due to this. This aspect has been treated in the first chapter of this book but is more in detail specified here.

In the reference case at the Machines division it is previously selected the following significant environmental aspects.

Examples of significant environmental aspects :

- **Waste management – non-hazardous waste**
- **Waste management – hazardous waste**
- **Raw material copper**
- **Consumption of electrical energy**
- **Consumption of heat energy**
- **Emissions to air**
- **Emissioner till Vatten**
- **Transportes**

Each one of these aspects may result in cost savings. As examples this is demonstrated in the following tables and diagrams.

Besides this it is possible to achieve savings due to reductions of environmental impact of other environmental aspects. Among these it is to be mentioned :

- **Other raw material** such as steel, cast iron and plastics
- **Consumption of some chemicals** may be reduced radically or

be eliminated completely

- More frequent and better maintenance of cooling equipment results in reduced emissions of freones that reduces impact upon the ozone layer in the stratosphere. The reduced consumption of freones etc chemicals for this also reduces the costs. Besides this the energy costs for the cooling plants are reduced, when they are in better condition.
- **Consumption of process water.** This is normally not a significant environmental aspect but may cost a lot of money for the organization.

11.2) Investments for the project

In order to fulfil the demand of continual improvements for the environmental impact of the organization it is needed some investments. It is observed that these investments often are very profitable. It is also observed that if one implements an environmental management system in a serious and correct way and obtain a full engagement from the personnel and management it is possible to obtain remarkable good results of the environmental and economical performance with very small investments in equipment and implementation.

The excel-chart below demonstrates the investment in the project work and for education of the personnel and other implementation investments

Summing up of costs for implementation of environmental management system ISO 14001

Project work :	Planning		Implementation - education and documentation			Control and corrective-		Total			
	hours	KSEK	Documentation hours	Educationdu hours	Total hours	Total KSEK	actions hours	KSEK	Hours	KSEK	
(Project group with bold style)											
Allan Andersson	400	160	180	200	380	152	200	80	980	392	
Flora Åskars	100	40	100	250	350	140	50	20	500	200	
Linus Bengtsson	100	40	125	100	225	90	50	20	375	150	
Dan Jörgensson	100	40		20	20	8	200	80	320	128	
Sten Boman	50	20	50	200	250	100	25	10	325	130	
(student (env. manager)											
Maria Sofin		0	350		350	140	30	12	380	152	
Zeke Michaelsson	20	8	200	100	300	120	30	12	350	140	
Management team	100	40		100	100	40		0	200	80	
Internal audits (the Group)							50	20	50	20	
Other personnel	50	13		1 200	1 200	300		0	1 250	313	
Additional investigation for energy saving :										30	
Fees for certification by SIS Certifiering AB :										150	
Sum manual work including SIS :									4 730	1 885	
Of which the project group :									2 175	870	

of administrative character.

To this it is to be added physical investments in equipment etc in order to implement the system and to fulfil the targets and continual improvements. :

Installed equipment during the running of the project

Briquette presses :	240
Can presses :	20
Containers for disposals including compressors for plastics, lables etc :	50
Timers and thermistors for process ventilation :	200
Logotype, pamphlet etc propaganda material :	40
Elimination of hot water at phosphatizzing, install door shutters etc heat saving activitie:	10
Collection equipment for cutting agent :	15
Collection equipment for solvents :	10
Rebuilding impregnation plant in order to reduce the emissions to air :	75
Installation of oil deposit :	50
Miscellaneous :	55
Sum physical investments during the project :	765

Total project cost : 2 650

During the year after the implementation of the environmental management system it also was performed some more investments in order to fulfil the targets and the continual improvements. :

Installed equipment etc the year after the implementation of the environmental management system

Investment in more rational ventilattion equipment :	400
Instruments for measurement of electricity :	80
Timers and control equipment in order to save energy in process equipment :	100
Tightening of heat leakage :	40
Doors between the bays of the building in order to save heat energy :	50
Adjustment and control of the heating system for the workshop :	20
Additional insulation of roof of office :	100
Elimination of ground heating at the reception of material :	5
More containers for waste management and labels :	10
Computerized system in order to calculate the amounts of chemicals (project work) :	10
Cleaning plant for spill oil (renovation and maintenance of present plant) :	10
Trimming of heat exchanger for the heating of the building :	50
New impregnation plant for exciters (this also was profitable from operational point of view) :	1 300
Miscellaneous :	25

Sum physical investments during the year after the implementation : 2 200

The prroperty owner performed some of these investments. The Pay Back for the investmants performed by the Motor division was less than one year - which means very profitable investments!

It is here observed a **total investment of 2 650 + 2 200 = 4 850 KSEK** in order to obtain an annual result of 5 400 KSEK/year according to point 5.10 in the following. This result is obtained one year form the implementation.

Here it ought to be mentioned that for keeping the environmental

management system alive it is needed continual activities by the environmental coordinator and other persons within the organization. This may need one man-years work annually, which means approx. 500 KSEK/year. Considering this the **net profit is 4 900 KSEK/year** which means a Pay Back less than one year - which means a very profitable project.

In the following is specified the result for each one of the significant environmental aspects together with other environmental aspects that also it have been done some efforts to reduce.

11.3) Economy matters concerning waste management

It is possible to do an analysis in EXCEL according to below in order to study the distribution of costs of disposals for landfill. As input data it is used the forecast and targets and information of costs from the waste management company. In the example it has been assumed that containers for deposit are 30 m³ which full contains waste of approx. 3,7 tons. The specific weight of the average waste may vary as times goes by dependent upon the amount of deposit that are sent for recycling.

Summing up of the costs for waste management before the the implementation of the environmental management system

Forecast of amounts tons/year without recycling

Normal not hazardous waste according to below :	Tons per year	Tons per m ³	SEK/ton	Container type	Number of containers	Container rent SEK/month	Number of transports per year	SEK per trans-port	Total cost SEK/year
Waste for deposit as land fill :	200		-600	Container 30 m ³	2	-700	54	-375	-157 772
				Small containers 0,6 m ³	20	-60			-14 000
				Small containers 0,06 m ³	50	0			0
White ordinary paper :	30		130	90 liter container	10	0	48	-100	-2 200
				190 liter container	5	0			0
Total for non-hazardous waste KSEK/year before the implementation of the environment management system :									-174

The costs are recorded with minus as they are cause negative results.

In the example the costs for managing the waste for deposit is 600 SEK/tons, which is a realistic figure for the industry. To this is to be added the cost for transport and container rent. The containers are emptied more seldom when it is implemented cost free recycling and therefore the amounts of waste for landfill are reduced radically.

In the example it is not implemented any recycling except ordinary white paper. All the rest of the disposals are pure waste for landfill. It also includes some metallic scrap.

This means that one in order to get a complete over-view even has to analyze the amounts of metallic scrap before and after the performed activities. Se further point 5.4. If one only compare the disposals excluding metallic scrap a too pessimistic figure is obtained. The real

result often is showed to be much better.

Below it is specified the result for non-hazardous waste after the performed activities.

Example of cost reductions for waste management after the implementation of the environmental management system and after implementation of recycling

Summing up of the costs for waste management after the the implementation of the environmental management system from Environmental Recycling AB

Forecast of amounts tons/year with recycling

Normal not hazardous waste according to below :	Tons per year	Tons per m ³	SEK/ton	Container type	Number of containers	Container rent SEK/month	Number of transports per year	SEK per transport	Total cost SEK/year
Waste for deposit as land fill :	10		-600	Container 6 m ³	2	-700	54	-375	-157 772
				Small containers 0,6 m ³	20	-60			-14 000
				Small containers 0,06 m ³	50	0			0
Combustible waste :	70		-250	Container 30 m ³	1	-350	12	-300	-25 300
				Small containers 0,6 m ³	10	-50			-6 000
				Small containers 0,06 m ³	50	0			0
Wood disposals :	20		0	Container 20 m ³	1	-350	12	-300	-7 800
				Small containers 0,6 m ³	5	-45			-2 700
Soft plastic disposals :	10		600	Container 20 m ³	1	-350	12	-300	-1 800
				Small hand compressor m ³	10	-40			-4 800
Card board paper :	15		200	Container 8 m ³	1		12		3 000
				Small containers 0,6 m ³	2	-50			-1 200
				Baskets	10	0			0
White ordinary paper :	30		0	90 liter container	10	0	24	0	0
				190 liter container	5	0			0
Total for non-hazardous waste KSEK/year after the implementation of the environment managemement system ::									-60

The costs are recorded with minus because they create a negative result. At maximum recycling it is observed that some disposals even is possible to get paid for. This is for example valid for recycling of soft plastics and cardboard paper. This however is under the condition, that they are taken care of in an efficient way and does not need too much volume. The organization has achieved briquette-presses that press the cardboard paper together into low-volume briquettes. The soft plastics are pressed together with manual compressors and are put into plastic bags.

It is observed that by these activities it is obtained that the costs for non-hazardous waste have been reduced from 174 KSEK/year to 60 KSEK/year, which means a **total reduction of 114 KSEK/year**.

According to the example it is **possible to save 114 000 SEK/year for managing of non-hazardous waste**

excluding metallic scrap when all actions are taken according to the first plans. This may give indications about the potential fir savings for a manufacturing unit of a couple of hundred employees.

11.4) Economy matters concerning Hazardous waste

This has been treated previously but is recorded with short comments below. It is possible to do an analysis in EXCEL according to below. As input data is used forecast and targets and cost information from waste management companies.

Reduction of hazardous waste **Barrier Water**. Here is recorded a potential of **savings of 76 KSEK/year** at a total management cost of 102 KSEK/year before the implementation of the activities. The amounts have been reduced from 35 tons/year to 11 tons/year.

Reduction of hazardous waste **Spill oil**. Here is recorded a potential of **savings of 38 KSEK/year** at a total management cost of 57 KSEK/year before the implementation of the activities. The amounts have been reduced from 6,7 tons/year to 1,8 tons/year.

Reduction of hazardous waste **Cutting agent (cooler water for machining)** Here is recorded a potential of **savings of 115 KSEK/year** at a total management cost of 160 KSEK/year before the implementation of the activities. The amounts have been reduced from 25,3 tons/year to 6,3 tons/year.

Reduction of hazardous waste **Washing water from phosphatizing plant**. Here is recorded a potential of **savings of 300 KSEK/year** at a total management cost of 300 KSEK/year before the implementation of the activities. The amounts and the costs have been eliminated completely.

Totally for Hazardous waste there are a potential to save $76 + 38 + 115 + 300 = 529$ **KSEK/year**. This may give an indication of what is possible to obtain for an industry of a couple of hundred employees. There are more potentials. Eventually it is possible to get paid for selling some hazardous waste as fuel in power plants.

Prize negotiations with waste management companies also may create savings.

11.5) Economy matters concerning raw material

The analysis of raw material may be distributed according to below :

Distribution of costs for raw material

- Reduction of amounts that have been purchased compared to what is used. The analyses concerns Reduction of **amounts of generated scrap** that remains to be sent for recycling. This is obtained by reducing the margins when purchasing the material. One possibility to do this it to better the control of processes.
- **Increased degree of recycling of scrap.** Thee amounts that previously have been sent for deposit as landfill are now to be recycled.
- **.Reduced amount of raw material in the products.** Product development is one

Total income for the Motor division before the implementation of the environmental management system

	Tons	Income	Container-	SEK per	Number of	Total	Indexx.
Metallis scrap according to below :	per year	SEK/ton	rent	transport	transports/year	income	not may-98
						SEK/year	kr/kg
Electro steel plates :	201	670	0	0	12	134 670	
Forged steel class II :	10	290	0	0	12	2 900	
Mixed scrap for fragmentation :	91	199	0	0	12	18 109	
Chips of steel :	188	175	0	0	12	32 900	
Fine cast iron scrap :	5	290	0	0	12	1 450	
Chips of cast iron :	60	175	0	0	12	10 500	
Stainless steel :	30	3 512	0	0	12	105 360	39,683
Aluminum scrap :	3	6 557	0	0	12	19 671	10,785
Chips of aluminum :	2	3 407	0	0	12	6 814	10,785
Enammeled copper :	22	10 932	0	0	12	240 504	13,687
Capton insulated copper :	15	7 987	0	0	12	119 805	13,687
Stator coils of insulated copper :	15	8 455	0	0	12	126 825	13,687
Nomex insulated copper :	15	8 455	0	0	12	126 825	13,687
Rough copper chips :	0	10 343	0	0	12	0	13,687
Copper chips from grinding :	0	7 987	0	0	12	0	13,687
Cable copper :	0	2 006	0	0	12	0	13,687
Bare copper :	10	11 987	0	0	12	119 870	13,687
Totally for metallic scrap KSEK/year before the implementation of the environmental management system.						1 066	

Below it is recorded the situation one year after the implementation and after that the recycling amounts have improved.

	Tons per year	Income SEK/ton	Container- rent	SEK per transport	Number of transports/year	Total income SEK/year	Index. not may-98 kr/kg
Metallic scrap according to below :							
Electro steel plates :	201	670	0	0	12	134 670	
Forged steel class II :	15	290	0	0	12	4 350	
Mixed scrap for fragmentation :	86	199	0	0	12	17 114	
Chips of steel :	188	175	0	0	12	32 900	
Fine cast iron scrap :	5	290	0	0	12	1 450	
Chips of cast iron :	60	175	0	0	12	10 500	
Stainless steel :	30	3 512	0	0	12	105 360	39,683
Aluminum scrap :	3	6 557	0	0	12	19 671	10,785
Chips of aluminum :	2	3 407	0	0	12	6 814	10,785
Enameled copper :	24	10 932	0	0	12	262 368	13,687
Capton insulated copper :	15	7 987	0	0	12	119 805	13,687
Stator coils of insulated copper :	15	8 455	0	0	12	126 825	13,687
Nomex insulated copper :	15	8 455	0	0	12	126 825	13,687
Rough copper chips :	5	10 343	0	0	12	51 715	13,687
Copper chips from grinding :	2	7 987	0	0	12	15 974	13,687
Cable copper :	2	2 006	0	0	12	4 012	13,687
Bare copper :	15	11 987	0	0	12	179 805	13,687
Totally for metallic scrap KSEK/year after the implementation of the environmental management system.						1 220	

Besides this it is possible to ask for quotations from different scrap management companies. After negotiations with these companies it is possible to obtain prize adjustments. For the motor division following result was achieved after finalized negotiations : 1 373 KSEK/year.

	Tons per year	Income SEK/ton	Container- rent	SEK per transport	Number of transports/year	Total income SEK/year	Index not may-98 kr/kg
Metallic scrap according to below :							
Electro steel plates :	201	755	0	0	12	151 755	
Forged steel class II :	15	505	0	0	12	7 575	
Mixed scrap for fragmentation :	86	322	0	0	12	27 692	
Chips of steel :	188	205	0	0	12	38 540	
Fine cast iron scrap :	5	495	0	0	12	2 475	
Chips of cast iron :	60	180	0	0	12	10 800	
Stainless steel :	30	4 750	0	0	12	142 500	39,683
Aluminum scrap :	3	8 089	0	0	12	24 267	10,785
Chips of aluminum :	2	4 853	0	0	12	9 706	10,785
Enameled copper :	24	10 950	0	0	12	262 800	13,687
Capton insulated copper :	15	10 265	0	0	12	153 975	13,687
Stator coils of insulated copper :	15	9 581	0	0	12	143 715	13,687
Nomex insulated copper :	15	8 897	0	0	12	133 455	13,687
Rough copper chips :	5	10 950	0	0	12	54 750	13,687
Copper chips from grinding :	2	8 212	0	0	12	16 424	13,687
Cable copper :	2	4 106	0	0	12	8 212	13,687
Bare copper :	15	12 318	0	0	12	184 770	13,687
Totally for metallic scrap KSEK/year after the implementation of the environmental management system.						1 373	

When comparing the different alternatives it is important to see that they are based upon index valid at the same date. In the example the index are from May 1998.

Here it is observed a further income of $1\,373 - 1\,066 = 307$ KSEK/year due to prize negotiations approx. one year after the implementation of the environmental management system.

Here also is added a summing up for the raw material year by year. All what is specified above is included in the following calculus :

It is here observed that it is found many new ways to take care of the copper scrap. The amounts that further are possible to recycle are analyzed year by year and are added to the table. These amounts are added to the amounts achieved during previous years for other types of recycling. The sum is multiplied with the sales prize that is achieved during the negotiations with the scrap management company.

In the example it is possible to see a potential of a further income of 785 000 KSEK/year which may give some indication of what is possible to achieve for an Industrial company with a couple of hundred employees when all of the targets and action plans are fulfilled.

In the same way it is possible to do an analyses of the amounts of the material contents that is possible to reduce by product development. This may be an amount 5-10% of the total material contents of the products that may be reduced. This gives radical reductions of the costs. An estimation of the potential is not possible to do generally but have to be analyzed from case to case. For the Motor Division it is possible to see a further potential of 60 to 70 tons copper/year which means 1,5 - 2,0 million SEK/year. But to achieve this it is important to perform extent development work for all of the products.

11.6) Economy matters concerning consumption of electrical energy

Below it is demonstrated a possibility to calculate the economical consequences of reduction of consumption of electrical energy. This is an EXCEL-analysis that as a suggestion are included in the same calculus-chart as the rest of the analyses for other environmental aspects. These may be linked to each other and thereafter generate a total summing up with diagram and all needed presentation material.

Example of cost reductions for Electrical Energy

Analysis of economy for reduced consumption of electrical energy						
Year	1995	1996	1997	1998	1999	2000
Target and result variable MWh/MW	8,0	7,1	5,6	4,5	3,8	3,4
Target and result variable MWh/year	7 209	7 810	6 160	4 950	4 180	3 740
Target and result fixed MWh/year	5 490	5 000	4 000	3 500	3 000	2 800
Target totally MWh/year	12 699	12 810	10 160	8 450	7 180	6 540
Starting point MWh/MW	8,0	8,0	8,0	8,0	8,0	8,0
Starting point fixed MWh/year	5 490	5 490	5 490	5 490	5 490	5 490
Eqivalens against starting point MWh/year	12 699	14 301	14 301	14 301	14 301	14 301
Differnece against starting point MWh/year	0	1 491	4 141	5 851	7 121	7 761
Accumulated difference MWh totally :	0	1 491	5 632	11 483	18 604	26 365
SEK/MWh	420	420	420	420	420	420
Total KSEK/year	0	626	1 739	2 457	2 991	3 260
Difference KSEK total ackumulated	0	626	2 365	4 823	7 814	11 073

In the example it is observed a potential of a cost reduction of 3 260 000 SEK/year when all targets and action plans are fulfilled until 2000.

11.7) Economy matters concerning consumption of heat energy

Below it is demonstrated a possibility to calculate the economical consequences of reduction of consumption of electrical energy. This is an EXCEL-analysis that as a suggestion are included in the same calculus-chart as the rest of the analyses for other environmental aspects. These may be linked to each other and thereafter generate a total summing up with diagram and all needed presentation material.

Example of cost reductions for reduced consumption of heat energy						
Year	1995	1996	1997	1998	1999	2000
Annual value MWh/year :	8 000	7 100	5 500	5 000	4 500	4 000
Average value for 3 years MWh/year :	7 967	7 300	6 867	5 867	5 000	4 500
Starting point annual value MWh/year :	8 000	8 000	8 000	8 000	8 000	8 000
Differenece against starting point MWh/year	0	900	2 500	3 000	3 500	4 000
SEK/MWh	284	284	284	284	284	284
Total KSEK/year	0	256	710	852	994	1 136
Difference KSEK total ackumulated		256	966	1 818	2 812	3 948

11.8) Economy matters concerning emissions to air

A way to reduce the emissions to air is to also reduce the amount of consumed chemicals. In many cases when it is chosen other chemicals than the ones that emits solvents it is possible to get cost reductions from the following reasons :

- Reduced amounts of the chemicals in the process
- Lower price of the chemicals for the process
- Reduced amounts or total elimination of supplementing chemicals such as solvents and detergents
- Lower price for supplementing chemicals such as solvents and detergents

It is therefore important to list all the chemicals that emits solvents and thereafter analyze them. A way to do this is to use the same calculus chart in EXCEL named Emissions to air, that is described previously.

Emissions to air from the Motor Division										
Denomination	Consumption of Chemicals			Emissions VOC to air			Emissions to air 1996			
	Article-number	1 994 kg/year	1 995 kg/year	Price SEK/liter	1 994 kg/year	1 995 kg/year	Price SEK/liter	Density kg/liter	Chemicals kg/year	VOC kg/year
Insulation varnish	1239 7001-225	5 130	5 320	42,50	227	236	42,50	0,96	2 726	121
Polyester resin	1235 5678-123	0	0	34,35	0	0	34,35	1,06	3 500	113
Duasolid primer	1243 7001-225	1 200	2 090	79,60	64	111	79,60	1,50	1 452	77
Paint Duasolid 50	1245 7001-225	1 800	50	116,60	161	4	116,60	1,30	36	3
Paint Duasolid 90	1244 7001-225	664	3 006	120,00	61	277	120,00	1,30	1 763	163
Xylene	1247 7001-225	1 805	2 970	11,10	23	38	11,10	0,86	832	11
Styrene	1240 5678-123	0	0	15,75	0	0	15,75	0,83	475	9
Cleaning agent	1241 5678-123	360	440	26,00	9	11	26,00	1,00	580	15
Cleaning agent	1242 5678-123	50	350	23,00	1	8	23,00	1,00	348	8
Acetone	1251 7001-225	87	123	11,60	1	2	11,60	0,79	108	2
Thinner	1252 7001-225	660	1 520	27,05	20	46	27,05	0,90	770	23
Thinner	1253 7001-225	1 690	3 075	19,60	37	67	19,60	0,90	1 800	39
Tectyl	1246 5678-123	38	35	40,80	2	2	40,80	0,87	30	1
Surface treatment	1247 5678-123	425	425	47,40	22	22	47,40	0,90	0	0
Washing agent triton	1248 5678-123	300	300	54,00	18	18	54,00	0,90	110	7
Hardener for Duasolid	1249 5678-123	1 740	3 100	93,50	130	232	93,50	1,25	1 968	147
Hardener RTV	1250 5678-123	0	80	168,50	0	11	168,50	1,25	63	8
Total		15 949	22 884		778	1 085			16 561	748

This calculus chart may be completed with another page where the previous figures are linked. Instead of the % emitted VOC it has to be recorded the process for each one of the chemicals.

Example of cost reductions for emissions to air

Example of cost reductions due to reductions of emissions to air						
Year	1995	1996	1997	1998	1999	2000
Annual value Kg/MW	14,8	5,9	4,3	3,2	2,5	2,1
Annual value Kg/year	13 320	6 490	4 730	3 520	2 750	2 310
Cost for chemicals KSEK/year	1 085	748	615	528	413	347
Cost for chemicals KSEKkg	81	115	130	150	150	150
Starting point SEK/Kg	81	81	81	81	81	81
Forecast production volume MW/year :	900	1 100	1 100	1 100	1 100	1 100
Equivalens and proportioned against starting point SEK/year	1 085	1 326	1 326	1 326	1 326	1 326
Difference KSEK/year		578	711	798	914	980
Difference KSEK total accumulated		578	1 289	2 087	3 001	3 981

Corresponding analyses have to be done for each one of the years that the targets are valid for. Thereafter the result of the analyses is added to an EXCEL-calculus according to the previous system recorded in this chapter. Such a summing up may look as above.

In the example it is calculated an equivalent cost for the chemicals distributed upon the emitted amounts. As the years go by and cheap solvents and chemicals are reduced some more expensive chemicals take over from a cost point of view. The equivalent cost in the example varies

between 80 SEK/Kg to 150 SEK/kg. Despite this the annual costs in the example are reduced as times goes by according to the example.

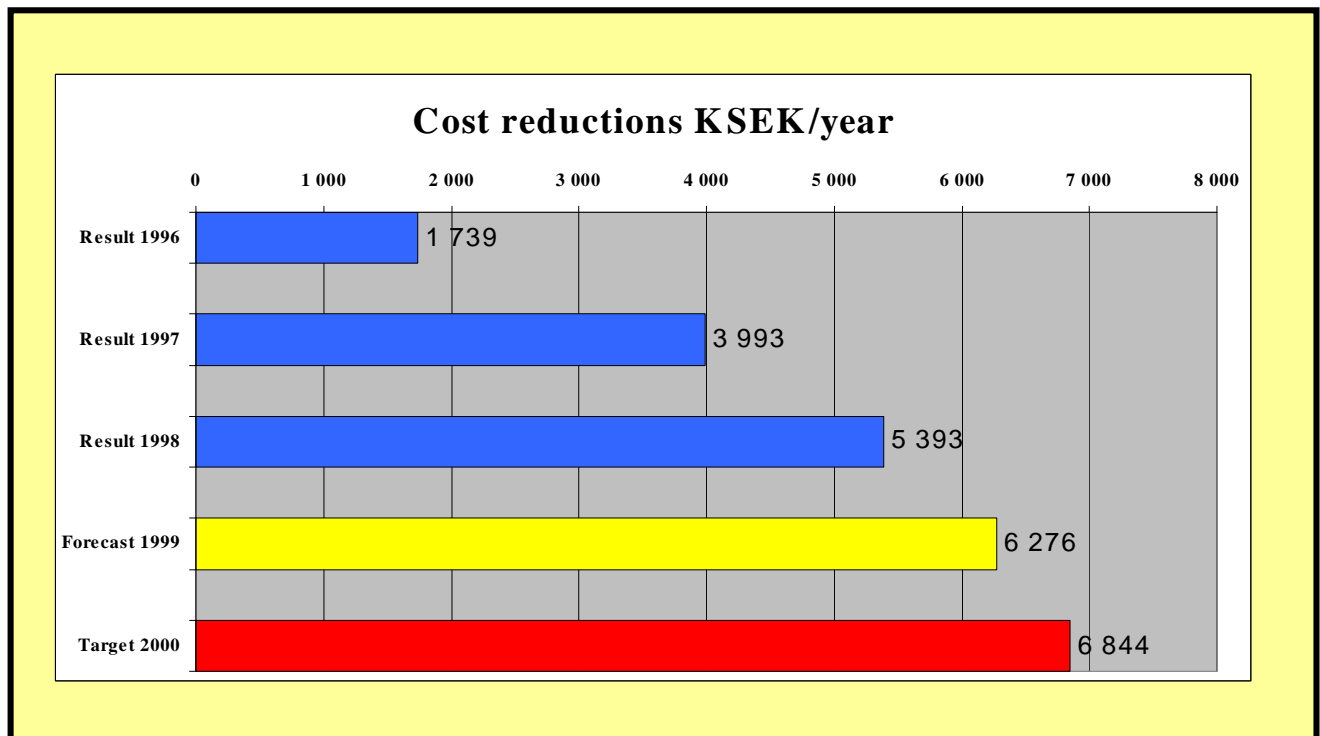
The last year it is saved 980 000 SEK/year compared to the situation if nothing had been done in order to reduce the emissions to air. This might give some indications about what is possible to obtain in an Industrial company with a couple of hundred employees. The demonstrated figure is somewhat exceeding the real result from the Machines division.

11.9 Summing up of economy matters

It is possible to analyze other environmental aspects in the same way as demonstrated above. As a final document of the results a diagram showing the results from year to year ought to be issued. This summing up is a good argument for convincing the management team to continue with the efforts in the environmental field.

The interest in approving investments concerning environmental matters is increased if it is possible to demonstrate good economical results.

Such a summing up is possible to do in a diagram in EXCEL that is linked to the previous calculus in the same chart. Such a diagram may look like below :



The background data is as below for the different environmental aspects :

	1995	1996	1997	1998	1999	2000
Waste as land fill	0	37	48	144	144	144
Hazardous waste - barrier water :	0	8	8	46	46	46
Hazardous waste - spill oil :	0	-11	39	39	39	39
Hazardous waste - cutting agent :	0	0	61	102	102	102
Hazardous waste - Phosphatizing water :	0	0	300	300	300	300
Scrap of Raw material copper	0	231	317	602	693	785
Reduction of electrical energy :	0	626	1 739	2 457	2 991	3 260
Reduction of heat energy :	0	256	710	852	994	1 136
Emissions to air :	0	578	711	798	914	980
Process water :	0	15	61	53	53	53
Total for the aspects above :	0	1 739	3 993	5 393	6 276	6 844

As an information it may be mentioned that in the real case ABB Industrial systems the result was a saving of 1,3 MSEK already during the first year (1996) during the implementation phase of the project. The result for the next year (1997) was 3,5 MSEK and for 1998 it was 4,7 MSEK.

In the fictive case for Environmental Production AB it is obtained a somewhat better result. The result is 1,7 MSEK during the first year (1996) and 3,99 MSEK during the year thereafter (1997). For year 1998 it was obtained 5,4 MSEK.

Below it is demonstrated a Pay Back calculus for the environmental management system of the Machines division :

The annual saving at year 1998 is :	5 400 KSEK/year
The annual personnel cost to keep the system alive :	- 500 KSEK/year
Total net profit :	4 900 KSEK/year

This may be compared with the investment in point 5.2 according to below :

During 1996 to the beginning of 1997 the investment for the project work was :	2 650 KSEK
--	------------

During the year after the certification (1998) the investment was :	2 200 KSEK
---	------------

Total investment one year after the certification :	4 850 KSEK
--	-------------------

This gives profitability with a Pay Back of : 1,0 year

A Pay Back of one year gives an annual profit of 100% of the investment. This is to compare with the 5% interests that it is possible to obtain if the money is put into bank

accounts instead.

This means a very profitable project – one of the most profitable during the history of the Machines Division!

According to the calculations, the time needed to recover the investment costs was 1,0 years. Today, only one full time post is needed to run this system, which provides the company with continual improvements in the areas of environmental matters and finance.

12) Final comments

The environmental work at ABB Motors have inspired Anders Allander to write a handbook concerning implementation management systems. There it is described much more examples of how to succeed in the environmental work. The description above only treats a small part of the work at ABB Motors.

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The successful environmental work at the Machines Division is documented in a this handbook **The Road to Environmental Certification** that is available to the public. It is a great tool in the hands of a serious environmental worker. It is available from :

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Bygatan 9
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Sweden

The previous company, ABB Industrial Systems AB has been divided into several companies. The Machines Division now belongs to ABB Motors AB.

More information can be found on the subject of the environmental activities of the Machines Division at www.technicart.com
On the Web-adress it also is possible to read about the book The road to environmental certification.