German Council for
SUSTAINABLE
Development

The Export of Second-Hand Goods and the Transfer of Technology

An Obstacle to Sustainable Development in Developing Countries and Emerging Markets?

A Study Commissioned by the German Council for Sustainable Development

by
Jörg Janischweski
Mikael P. Henzler
W. Kahlenborn

Adelphi Research gGmbH
Caspar-Theyß-Str. 14a
D-14193 Berlin
www.adelphi-research.de

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SUSTAINABLE
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The German Council for Sustainable Development

The German Council for Sustainable Development has the task to provide recommendations on sustainability politics, to suggest model projects and to strengthen the topic in the public. The council was appointed by Chancellor Gerhard Schröder in April 2001. In June 07, Chancellor Angela Merkel appointed new members and reinforced the tasks of the council.

Office of the Council
for Sustainable Development
www.nachhaltigkeitsrat.de
info@nachhaltigkeitsrat.de

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Executive Summary

The Council for Sustainable Development has engaged Adelphi Research to investigate the following topics:

- The export of second-hand machinery and equipment;
- The export of second-hand vehicles;
- The energy efficiency of buildings in various developing countries and emerging markets, exemplified by case studies.

In all three cases the main focus is on the extent to which recent developments in each field pose an obstacle to the goal of sustainable development.

Trade in second-hand machinery and equipment

The transfer of second-hand machinery and equipment has now evolved to become an **important business sector** - almost unnoticed. Enterprises in developing countries and emerging markets have recognised that second-hand machinery and equipment from industrialised countries represent a low-cost and fast solution to the problem of replacing outdated machinery and/or building up new capacities. At the same time machinery dealers from industrialised countries have discovered the market gap and are now extremely active in this field. The import of second-hand goods in the machinery and equipment sector has therefore become a daily reality in developing countries and emerging markets. The extent and the structure of this trade has been revealed for the first time world-wide in the context of this study.

Second-hand machinery and equipment **to the value of more then 100 billion US dollars** are sold every year, primarily to developing countries and emerging markets. This figure is substantially higher if exports in the context of foreign investments are also considered. The transfer of second-hand machinery and equipment sometimes shows double-digit rates of growth. For many developing countries and emerging markets the import of second-hand goods already accounts for a large proportion of all machinery imports.

However, for importing countries there is a **serious conflict of interests** between economic development and the negative consequences for the environment. Developing countries and emerging markets' stances vary between refusal and consent. Some try to control while others promote such imports. As a result a multiplicity of different laws as well as tariff and non-tariff barriers are applied. The only identifiable, internationally uniform trend is the continual and sometimes fundamental change of policy in the various countries, which reflects the prevailing uncertainty concerning the effects and the significance of second-hand imports.

Trade in second-hand vehicles

The international trade of used vehicles reveals a similar picture. In view of rising environmental standards in the countries of origin and the active interest of consumers in developing countries and emerging markets, trade continues to flourish. Turnover from **second-hand vehicles has a value of approximately 50 billion US$** annually. A large portion of it goes to developing countries and emerging markets. Almost 500,000 second-hand vehicles with a unit price of less than € 2,500 and an average age of 6-8 years originate from Germany alone. These vehicles

are mainly sold to Eastern Europe and Africa. So far the various importing countries have not been able to find a clear and uniform strategy as regards the transfer of second-hand vehicles. As in the sector of second-hand machinery and equipment, ambiguity tends to prevail on how to deal with the phenomenon of increasing imports of second-hand goods.

The environmental impact of the export of second-hand goods

The transfer of second-hand goods manifests itself in various different forms, with a large number of interest groups and marginal conditions playing a role. On the one hand, sort of "win-win" situations can develop where the social situation and the environment benefit from the sustainable development of the economy. On the other hand over the years these transfers can hinder sustainable development in developing countries and emerging markets. The latter scenario gives grounds for concern because at present the large numbers of second-hand exports are neither monitored nor critically examined or addressed at all. The **multiplicity of small amounts of imported goods** can cause **substantial environmental damage in the accumulated effect**.

Regardless of the fact that the trade in second-hand machinery or second-hand vehicles cannot simply be put into polluting or ecological categories, the study shows that the net impact on the environment of exported second-hand goods is very high altogether. More in-depth investigations in the sectors of **steel making, energy production, cement production and mineral oil processing** show that there is **additional pollution of a considerable dimension**. The transfer of used fossil power stations alone, with an overall capacity of 23 gigawatts, causes additional annual emissions of **approximately 2.2 billion tons CO_2** over a 10 year period in comparison with modern power stations (BAT). Another example are annual exports of over 300,000 second-hand vehicles to West Africa. They lead to an annual additional emission of 6,000 tonnes of nitrogen oxide and 70,000 tonnes of carbon monoxide. The substantial emissions emanating from the rapidly growing number of second-hand imported goods in developing countries and emerging markets are alarming, in view of local and regional environmental protection as well as global protection of the environment (particularly the protection of the climate).

The energy efficiency of buildings in developing countries and emerging markets

The **proportion of building activities world-wide accounted for by the developing countries** has risen from only 10 per cent in 1965 to **29 per cent** in 1998. In many of these countries there are high rates of new buildings being constructed. In China, for example, almost half of all urban dwellings were only built in the 1990s (1998 figure). Here, as in the other countries investigated, attention is not usually paid to constructing energy-efficient buildings.

Buildings typically use up one third of a country's energy and about half of its electricity. At the same time building methods which are not energy-efficient often result in buildings having an energy consumption which is 50 per cent higher. The **maladjusted building methods** in many developing countries and emerging markets therefore have **considerable effects on** the **energy consumption and the greenhouse gas emissions** of these countries. In China alone an additional 800 million tons of CO_2 will result in the next 10 years due to non energy-efficient building methods. If one considers that buildings have a life span of sometimes more than 100 years it becomes clear that misguided planning here will lead to large problems in the future.

One of the **main reasons for non-energy-efficient methods of constructing new buildings** in developing countries and emerging markets is that it is only in the rarest cases that the owner is at the same time the user of the building. The owner is usually only interested in producing plenty of useful space at as a low a price as possible. Apart from this, the state often neglects or fails to provide suitable energy efficiency standards for buildings.

Conclusions

During the 1980s and the 1990s an intensive environmental policy debate took place concerning the relocation of entire branches of industry as a result of stricter environmental legislation. However – apart from a few exceptions - no considerable relocation has so far occurred. The recent transfer of environmental pollution through the export of second-hand goods is equally significant in terms of environmental policy. Yet this topic has so far received limited attention. This is certainly due, not least, to the poor availability of data, but also to the complexity of evaluating individual exports. In view of the recognisable effects on the environment, however, it will become **imperative to think about solutions**.

In principle a **broad spectrum of options** is available. Due to the heterogeneity of the subject matter uniform approaches for all industries and countries will not be possible nor reasonable. However it can be assumed that in principle the upgrading of second-hand capacities and the use of advisory services to determine particularly critical components would allow substantial reductions in emissions. Development banks, export credit institutes and also operator models could cushion the higher capital outlays for the purchase of new installations or the costs of upgrading second-hand imported goods. Further potential starting points are the introduction of benchmarking and labelling systems, minimum standards for certain second-hand exports and guidelines for manufacturers and dealers, possibly in the context of the OECD. It might even be possible to bring about a link between the trading of second-hand goods and discussions and activities in the field of the Clean Development Mechanisms (CDM) or to extend the scope of the CDM to include the sector of second-hand machinery and equipment. The similarity in the problems, the objectives of the CDM and the scale of the potential for savings estimated in this study on the basis of case studies seem to justify this approach. In the case of the export of second-hand vehicles a special evaluation and development of the current "end of life" policies would certainly make sense.

For the further debate of the topic it should be noted that **many questions remain open**. Numerous details are still unclear. Questions concerning the causes and the effects of the trade in second-hand goods and the potential influence of environmental policies lack answers. For example, the environmental success of various import policies is largely unknown. Additionally, the topical question remains unanswered as to the extent to which the negotiations in the framework of WTO and GATTS alter the trade with used machinery, equipment and vehicles and to what extent they trigger reactions related to the environment. The many open questions should nevertheless encourage action, rather than passive acceptance of the developments.

List of abbreviations

ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
BAT	Best available technology
BDEx	Association of German Exporters
BOT	Build operate transfer
BPD	Barrel per day
CDM	Clean development mechanism
CO	Carbon monoxide
CO_2	Carbon dioxide
ELV	End of life vehicles (old cars)
ETM	Energy-efficient technologies and materials
ETTV	Envelope thermal transfer value
DCE	Developing countries and emerging markets
FDM	Fachverband des Deutschen Maschinen- und Werkzeug-Großhandels e.V. (Association of German Wholesalers of Machinery and Tools)
GF	Second-hand vehicles
GHG	Greenhouse gases (Treibhausgase)
GMA	Second-hand machinery and equipment
HVAC	Heating, ventilation, air conditioning
ISIC	International standard industrial classification of all economic activities
NAICS	North American Industry Classification System
NFZ	Commercial vehicles (CV)
NO_x	Nitrogen oxide
OTTV	Overall thermal transfer value
PM	Particulate matter
SO_2	Sulphur dioxide
SO_x	Sulphur oxide
TBPD	Thousand barrels per day
TOE	Barrel oil equivalent
TSP	Total suspended particles
TWh	Terawat hour
VOC	Volatile organic compound
WZM	Machine tools (MT)

List of illustrations

1 A bird's eye view of the problem and its background

1.1 The problem and the initial situation

The German Council for Sustainable Development, besides advising the German Federal Government on a national strategy for sustainability, pro-actively addresses questions of sustainable development. These are of a fundamental nature and are not directly connected with the current discussion regarding a national strategy for sustainability. To lay the groundwork for its concern with the subject the Council commissioned Adelphi Research to prepare a study. The aim was to present the current state of knowledge concerning "export of second-hand goods and transfer of technology".

There is currently no comprehensive information available concerning the extent to which the export of vehicles, equipment and products that are not (no longer) ecological and resource-efficient to developing countries and emerging markets from Germany and other important EU states contributes towards building up a resource-intensive system of production and consumption that puts back the realisation of a model for sustainable development for decades.

Against this background the present study is devoted to three selected areas: a) second-hand machinery and equipment, b) second-hand vehicles and c) the energy efficiency of buildings. In each area there is an analysis of the present literature on the subject and an investigation of the statistical data.

Trading in second-hand machinery and equipment has evolved to become an important business sector world-wide - almost unnoticed. The reasons for the rapidly growing interest in trading in second-hand machinery and equipment are complex. On the one hand a role is played by structural changes, increasingly shorter investment cycles, more stringent (environmental) standards and product requirements as well as corporate bankruptcies in the industrialised countries. On the other hand progressing globalisation, better communication and information media, increased privatisation, improved means of transport and local economic growth in the countries of destination have a positive impact. In view of the difference in the levels of income between industrialised countries and developing countries and emerging markets Standards & Poors even see "considerably more potential" for trade in second-hand machinery (Gersten, 1997). Enterprises in developing countries and emerging markets have apparently recognised that second-hand machinery and equipment from industrialised countries represent an economical and fast solution to the replacement of outdated machinery and/or the building up of new capacities. Consequently, they are becoming increasingly active in the sector of second-hand machinery and equipment. Sellers are equally committed, especially machinery dealers in industrialised countries.

A similar picture presents itself as regards international **trade in second-hand vehicles**. Business is booming in view of rising environmental standards in the countries of origin and the keen interest of consumers in developing countries and emerging markets.

The transfer of second-hand machinery and equipment and second-hand vehicles does not yet play a role of any significance in the public debate. This is particularly remarkable if it is considered how comparatively intense discussions are concerning the transfer of environmentally-friendly technologies (e.g. Agenda 21) or the cross-border transport of harmful waste (e.g. the Basle Convention). The low amount of public debate is probably a result of the complexity of the subject-matter: the export of environmentally-friendly technologies is something positive. The export of harmful waste is something negative. But **what impact** on the environment does the export of second-hand machinery and equipment and of second-hand vehicles have?

This question is indeed not one that can be answered easily and unequivocally. The transfer of second-hand goods can manifest itself in virtually any form with a large number of interest groups and marginal conditions playing a role. On the one hand sort of "win-win" situations can develop where buyers, sellers and the environment all benefit in the sense of sustainable development. On the other hand due to the long lifetime of the capital stock in relation to energy, a clog may be placed on sustainable development in the developing countries and emerging markets for many years. In some circumstances this may even exacerbate their technological lag (see figure 1.1).

The latter scenario gives grounds for concern for while local and international environmental groups are often successful in raising objections in the case of critical, large-scale projects, it is likely that a large number of smaller projects can lead to a multiplicity of "**mini Bhopals**", as one interview partner so accurately warned.

There seems to be awareness in industry that the export of second-hand goods can have a negative impact on the environment. In order to set an example, the "**Green Elephant**" is awarded as a prize every year for a particularly sustainable transfer at RESALE, the world's biggest trade fair for second-hand machinery.

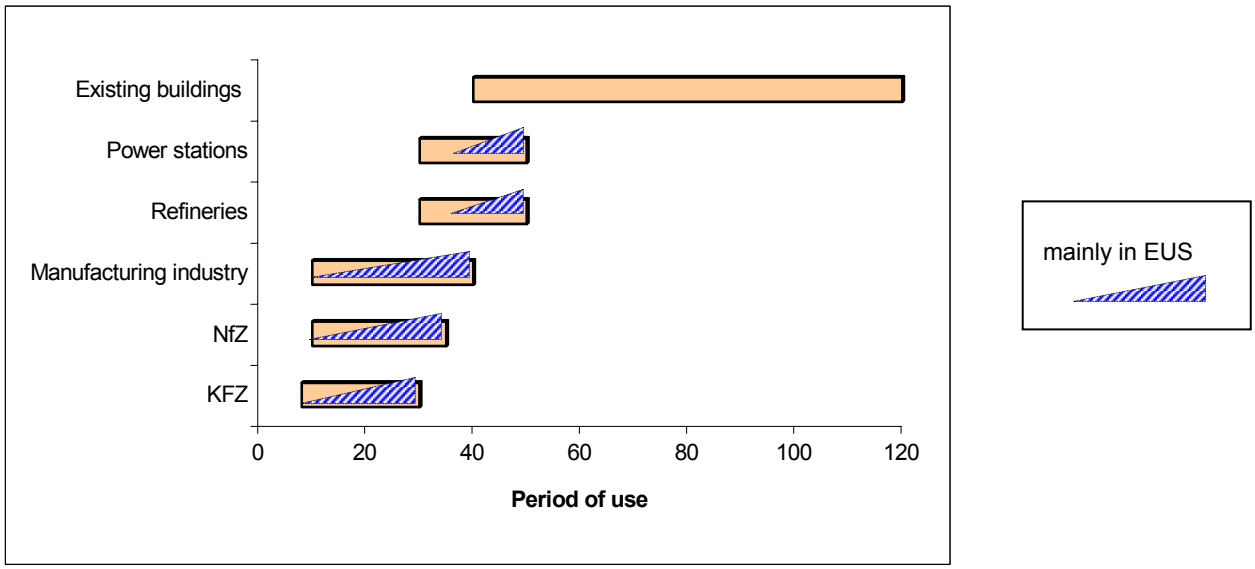

Figure 1.1: Typical lifetime and renewal of the capital stock
Source: taken from Weltenergie-Ausblick 2000, IEA

What perhaps gives even more grounds for concern, however, are what could be called the "creeping Bhopals“, i.e. situations in which capital stock is used over the long term in an inappropriate form, mindlessly and unnecessarily. In addition to the use of second-hand machinery and equipment and second-hand vehicles this can also include the completely **insufficient energy efficiency of existing buildings**. This study will also give consideration to this aspect.

In view of a market which is already important and also growing rapidly and some clear signs of irreversible damage brought about by the export of second-hand goods and the inappropriate application of technology, it seems desirable to carry out some **pioneering work** and to collate what little date there is - data which can often be obtained only from unofficial sources.

The aim of this study *is to clarify to what extent the transfer of vehicles, equipment and products which have a polluting effect on the environment and which strain resources from Germany and other countries of advanced technological development to developing countries and emerging markets obstructs sustainable development in these countries.*

According to the stated aim of the study this specifically includes:

- The collection of data concerning the export of second-hand vehicles, environmentally intensive machinery and entire plants or parts of plants from Germany and other industrialised countries to developing countries and economies in transition.
- The collection of data concerning the scope of new buildings completed or planned in selected developing countries and countries in transition where the climate is very warm or very cold and the buildings are not in line with the state of the art that could be reasonably expected in view of the climate in these countries.
- An estimation of the additional emissions caused and of the increased consumption of energy.
- The preparation of an overview of the import policies in the individual countries of destination.
- A summary of the causes for the export of second-hand equipment, machinery and vehicles and for buildings with inadequate heat insulation.

1.2 Demarcation of the subject matter and main points of focus

The question as to whether the export of second-hand machinery, equipment and vehicles or patterns of consumption to developing countries and emerging markets is sustainable is one that is extremely complex and to which there is no clear answer, influenced as it is by a large number of technological, economic, political, legal and social factors. In view of this complexity it seems neither meaningful nor possible to carry out a complete analysis of all developing countries and emerging markets and of all industrial sectors in the context of this study.

*The "Journal of Commerce" comes to the conclusion that a market analysis regarding the export of second-hand machinery and equipment would probably have to build up on a mosaic of "**anecdotal pieces of evidence**" (Gersten, 1997) and "Statistik Austria" even speaks of "**nightmares**" for those who wish to make an international comparison of second-hand machinery as each piece of used machinery is unique (Rittenau).*

Thus on the one hand the number of countries of destination for the exports is limited to countries that are particularly relevant, large countries or countries which are representative for their region. Thus in this study **countries of destination** are defined as follows:

- in the field of second-hand machinery and equipment: Brazil, China, India, Indonesia, Morocco, Mexico, Poland, Russia and South Africa;
- in the field of second-hand vehicles: Eastern Europe and Africa;
- in the field of energy-efficient buildings: China, the Philippines and Pakistan.

On the other hand in the field of second-hand machinery and equipment a number of **focal sectors** have been defined in order to demarcate the subject matter. In selecting these sectors it was taken into account that they have a particularly damaging impact on the environment, that second-hand exports are of relevance in these sectors and that they are also so homogeneous that statements made about their impact on the environment can also be taken as being representative. Thus the following focal sectors have been selected:

- the production of steel (ISIC 371),
- the cement industry (ISIC 3692),
- the generation of energy (ISIC 410) and
- the processing of mineral oil (ISIC 353).

A further demarcation was made in the field of **"energy efficiency".** As a rule energy efficiency is broken down into four areas: buildings, the generation of energy, transport and industry. Developing countries and emerging markets usually have a need for action to be taken in all these areas. This study will also particularly focus on the energy efficiency of buildings and particularly new residential and commercial buildings to be built. It is precisely in these areas that the consumption of resources is likely to be particularly high.

1.3 Procedure and methodology

In order to be able to make statements about the impact of the export of second-hand goods on sustainable development in the countries of destination it is necessary to make a **fully researched audit** of the transfers. For this purpose it was first ascertained who exactly supplies what where and for what reasons and what adverse effects this has on the environment in comparison with the "best available technology" (BAT).

In detail this meant

- recording and evaluating a large number of secondary sources,
- collecting primary data (where necessary),
- researching into the general status of the international debate and research,

- preparing revealing case studies,
- making quantitative and qualitative estimations of the impact on the environment .

On this basis the **causes and motives** of the parties involved in the export and import of goods with poor environmental standards were highlighted and analysed.

When collecting data concerning the **transfer of second-hand machinery and equipment** a particular **search strategy** was adopted as trade in second-hand machinery and equipment not only plays a subordinate role in the public debate, but **there are usually no available statistics** either (exception: see NAICS for "used goods“, Annex 1.1).

A first hint of what could be meaningful search strategies for this study resulted from a brief investigation of the database of literature, GBI. As became apparent from this database, only enterprises and trade journals, if at all, concern themselves with the subject of "second-hand machinery". Almost without exception information on the combination "second-hand machinery" and "export" is only available in the case of enterprises. So for this study we interviewed respondents from enterprises and corporate associations and also examined and statistically evaluated the internet presence of dealers in second-hand machinery.

Furthermore various statistics, studies and newspaper articles were evaluated which give an insight into the quantity and quality of exports of second-hand machinery and equipment. Of particular importance were the bfai CD ROMs on foreign trade and payments and the internet with the aid of which we searched through more than 10,000 databases according to relevant search criteria. On the basis of this data and taking account of any double counts, the authors were able to start to quantify the export of second-hand machinery and equipment in the focal sectors.

The data as regards the **export of second-hand vehicles** is considerably more abundant as trade in second-hand vehicles in Germany is recorded by the Federal Statistical Office. There are a number of studies and other data sources which form a solid basis for the quantification of the flow of goods. Another aspect which facilitates the matter is that this flow of goods shows a certain homogeneity among exported goods in comparison with second-hand machinery and equipment.

The estimations of the impact on the environment for both areas of technology, second-hand machinery and equipment and second-hand vehicles, are first based on the volumes transferred and the quality or age structure of the goods. It was attempted to highlight the differences between

- the "best available technology“ (BAT) and the second-hand solution (“second best available technology”),
- the second-hand solution and the existing solution ("third best available technology“) and
- the BAT and the existing solution.

With the aid of macro-estimations and exemplary process-comparison estimations the impact on the environment was then quantified.

The subject of the "**energy efficiency of buildings**“ is both thematically and methodically separate from the other areas of technology. The data in this area is quite abundant. Studies which partly deal with similar questions have been collated and evaluated. A country in various typical climatic zones was taken as an example and analysed in greater detail as being representative of the zone in question: China for cold zones, the Philippines for a tropical climate and Pakistan for a hot climate.

1.4 The structure of the study

The structure of the study is determined by three areas of technology. **Chapter 2** deals with the transfer of second-hand machinery and equipment. On the basis of the general legal conditions in the countries of destination the distribution channels are analysed and various market information is collated concerning the quality and the quantity of the second-hand machinery and equipment. Apart from this, typical problems are listed which can occur in connection with the transfer and use of second-hand machinery and equipment. Detailed information on the status of imports of second-hand machinery and equipment in the countries of destination or sectors of destination finally form the basis for the estimations of the impact that transfers of second-hand machinery and equipment have on the environment.

Chapter 3 discusses the export of second-hand vehicles and is structured in a similar way to chapter 2. It starts with the general legal conditions and an estimation of the size of the market in Germany and in other industrialised countries. There follows a discussion of the special features of the markets in Eastern Europe and in Africa. This is done on the basis of the case study of "Benin“. The estimations of the impact on the environment are largely based on export statistics.

Chapter 4 on the energy efficiency of buildings in developing countries and emerging markets starts with a brief introduction to the problem. Building up on this, three case studies are presented separately - one for each climatic zone selected.

The evaluation of the results (**chapter 5**) is the collation and interpretation of the reasons for the maladjusted transfer of technology and patterns of consumption. As a second step, a comparison is made between the quantitative results of the estimations from the three areas of technology.

Chapter 6 then summarises again the discussion of the advantages and disadvantages of the export of second-hand goods and provides an outlook for how this discussion could be continued.

2 The transfer of second-hand machinery and equipment

2.1 The general legal conditions regarding second-hand machinery and equipment

The stances of **governments** in developing countries and emerging markets vary between refusal and consent and they thus try to both control and to promote the import of second-hand machinery and equipment. They produce a large number of laws, some of which can be construed in different ways, and also employ tariff and non-tariff barriers. The only recognisable, internationally uniform trend is the constant and partly fundamental change of policy of the various governments which also shows the uncertainty as to the effects and the significance of the sector.

This becomes particularly apparent in the case of **Indonesia**. Since 1999 the country has reformulated its import policy nearly every six months. With the aim of achieving economic growth and in view of the poor purchasing power, the Indonesian government is currently giving official backing to "affordable" machinery. At the same time the government hopes that many jobs will be created in the so-called "reconditioning companies“. These are supposed to restore the imported second-hand machinery and equipment (US-International Market Insight). However there is also a list of banned products and second-hand machinery and equipment must be checked by a state-appointed expert before being imported.

Many developing countries and emerging markets tend to react restrictively to the import of second-hand machinery and equipment. The reason for this is usually to protect local industry from cheaper alternatives and to avoid obsolete technology entering the country. Thus **Brazil**, for example, places considerable restrictions on the import of second-hand machinery and equipment. In principle second-hand machinery and equipment can only be imported if it has either been proved to create jobs, makes a considerable contribution to the export orientation of the country or cuts production costs on a permanent basis. Apart from this, no machinery may be imported which competes in any form with local products. Furthermore there is a complicated approval procedure. This involves providing evidence that the machinery and equipment has a remaining lifetime of at least 50 per cent.

In **China** the import of second-hand machinery and equipment has been strictly regulated since 1998 and is usually only possible in connection with investments. However exceptional approvals may be granted in individual cases. The reasons that the Chinese government gives for imposing restrictions on imports are a reduction in the damage to the environment, an improvement in safety and the prevention of illegal imports. To what extent the latter applies to the equipment that is the subject-matter of the present study remains an open question. **Mexico** tries to protect local industry by imposing a labelling obligation, keeping stocks of spare parts and giving guarantees. However above and beyond this the import of second-hand machinery and equipment is generally possible. **India** largely bases its import policy on an age scale at present, heavy industry being afforded particular privileges.

Other countries, such as **Poland, Russia, South Africa and Morocco,** impose only slight

restrictions on imports or none at all. In view of their financial problems, many regions increasingly see second-hand machinery as a low-cost alternative to finance their economic growth. The Iranian government, for example, plans to expand steel production from seven to 14.7 million tonnes, power station capacities from 26,000 MW to 35,000 MW and the production of petrochemical products from 13 million to 38 million tonnes by the end of the third development plan, preferably on the basis of second-hand machinery and equipment. It is therefore facilitating the import of second-hand machinery and equipment ("*Making use of second hand machinery as a means of industrial development might be a solution for passing through underdevelopment. Application of such machinery might be fruitful in the country's development*", Bahman Arman, Adviser to the Iranian government, Teheran Times, 2001).

Country	General legal conditions
Brazil	Considerable restrictions,;the creation of jobs, orientation towards, cost- cutting, no competing products. Complicated approval procedure, remaining lifetime of 50%. Taxes usually the same as for new machinery..
China	Strictly regulated since 1998, only with express approval, list of prohibited products with around 150 types of second-hand machinery, import possible in the context of investments after approval, dispute between various ministries as to the extent of their responsibilities.
India	Automatic approval in the case of machinery; import licence required for machinery that is ore than 5 years old. 5-10 years: it is checked whether the product is a competing product. >10 years: no approval with the exception of heavy industry. Second-hand machinery must comply with the specified environmental and industrial safety standards.
Indonesia	Possible since 2000. However list of prohibited products, second-hand machinery must be checked by a state-appointed expert.
Morocco	Second-hand imports are treated in the same way as new imports
Mexico	Import possible subject to conditions: guarantees of at least one year, supply of spare parts: labelling requirement (e.g. “not new”, "put out of operation on..“, "modified “). A special import permit is required in certain sectors.
Poland	No restrictions in principle
Russia	Slight restrictions, sometime registration is required with responsible ministry.
South Africa	No restrictions in principle, but importer has to arrange for import controls prior to import. Conformity with international standards required - relief measures as regards customs.

Figure 2.1: General legal conditions in the countries of destination for the import of second-hand machinery and equipment[1]

When comparing the various import policies it becomes apparent that the governments in question have obviously recognised the risks and opportunities of the import of second-hand machinery and equipment and are playing, as it were, a repertoire of constantly recurring political stylistic elements. These mainly include an age limit, certain test procedures, lists of banned products and usually a "loophole" as well in order to enable strategically important projects to be carried out. However it appears that the protection of indigenous industry plays

1 The US government lists the latest import regulations on the internet at http://web.ita.doc.gov/machinery/usedmach.nsf .

a greater role than the fear of negative effects on the environment.

The legislature in the various countries meets with a divided opinion among **local industry**. Thus the "Indian Paper Manufacturers Association“ (IPMA) has strongly criticised the import restrictions imposed in 1999. The Association argues that investments in new machinery are not possible at present due to the poor financial shape of the industry and the sluggish Indian economy and that the import of second-hand goods represents the only way of modernising the outdated equipment. The rapid technological development in OECD countries, they say, means that a large number of second-hand machines with quite a long remaining lifetime are available on the world market (“IPMA flays import bar on second-hand capital goods”, Business Line, 18 June, 1999).

In view of the problems of controlling the import of second-hand machinery and equipment that is harmful to the environment, developing countries have turned to the industrialised countries and suggested that they exercise better control over their exports (The Alliance for Responsible Atmospheric Policy, 1998). However second-hand machinery and equipment does not usually play any role at all or only a subordinate role in the **export policy** of an industrialised country. The US American **Ex-Im-Bank** supports the export of second-hand machinery and equipment by providing better repayment modalities, depending on the remaining lifetime of the machinery and equipment (Policy Handbook 1995, revised 9/99). For this purpose the bank has even developed its own "second-hand machinery questionnaire“.

In its Committee for Industry, Foreign Trade, Research and Energy the European Parliament has briefly touched the subject of the export of second-hand machinery. "It requests the Commission to consider export restrictions on second-hand and inefficient machinery, equipment and vehicles from the EU ...“ (source: European Parliament, draft report of 18 Dec. 2000).

The **Republic of Korea** has recently created some legal conditions of quite a different type with regard to the export of second-hand machinery and equipment. The recession unleashed by the Asia Crisis has meant that the degree of utilisation of the equipment in the various areas of production has fallen to a minimum. As the country urgently needs foreign currency, in 1998 about 10 per cent of all equipment built between 1991 and 1997 was put up for sale. The Korean government is actively encouraging the sale of equipment to the tune of an estimated 14.6 billion US$ - one third of the original costs of investment - and has not only instructed the Korea Trade Promotion Agency to sell the equipment to emerging markets, but has also ensured that it can be shipped without having to overcome bureaucratic hurdles. It is thus meeting the conditions imposed by the IMF (“S. Korean firms put more factory equipment on sale abroad”, Agence France Press, 15 September 1998). The news was also seized on and published by Indian dailies.

2.2 Analysis of the distribution channels for second-hand machinery and equipment

There are a number of **general differences** between trading in new goods and trading in second-hand goods:

- As a rule the goods are not offered by the manufacturer, but by the user or its authorised dealers. Trading in second-hand goods is not usually in the main interests of the users.
- The need for new goods is unrelated to the need for second-hand goods. There is not even any obvious connection between supply and demand for second-hand goods.
- In view of the large number of product users there are also very great differences in the quality of second-hand goods. There is a great deal of uncertainty regarding the quality of second-hand goods (asymmetry of information).
- There are usually more suppliers who sell to markets for second-hand goods than there are manufacturers who sell to markets for new goods. Second-hand goods thus have a wider geographical distribution.

These general considerations are largely confirmed in the case of trade in second-hand machinery and equipment. The exhibitor statistics for the world's biggest trade fair for second-hand goods, RESALE 2002 in Nuremberg (Germany), provides a rough overview of the composition of the companies interested in the export of second-hand machinery.

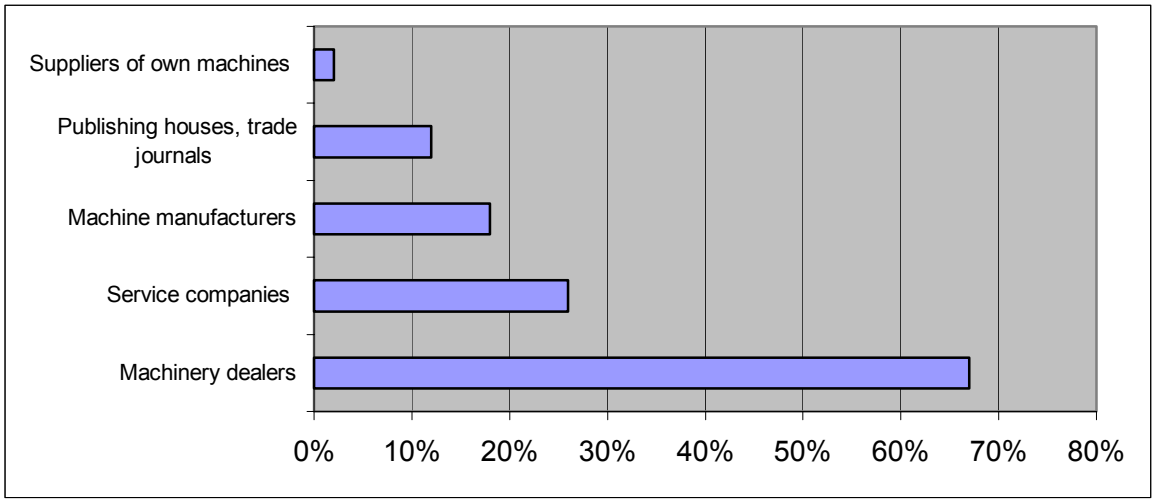

Figure 2.2: The structure of exhibitors at RESALE 2002 in Nuremberg (multiple nominations possible)
source: Hess GmbH, 2002

As can be seen, the export of second-hand machinery and equipment is largely determined by the manufacturers of machinery, suppliers offering their own machinery (users of machinery), machinery dealers, and service providers. The roles of these companies will now be examined in detail.

2.2.1 Machinery dealers

The group of companies that is obviously most important for the export of second-hand machinery and equipment are machinery dealers. The great interest of the dealers is based on the assumption that some of the machinery that has become superfluous in one country can still have a considerable market value in another country.

Dealers in machinery usually have access to an excellent network of international personal contacts. They generally know the production enterprises in the OECD countries that are interested in rapid disposal. The machinery is then either bought up or passed on to others at typical commissions of 10 per cent. Trade in second-hand machinery therefore thrives on communication between the parties involved. This is so to a greater degree than is the case in other product areas. Most dealers are interested in direct **short-term profit**. Their sole product is the second-hand machine/piece of equipment itself. After-sales service is not usually included unless this is expressly desired by the customer and the customer is prepared to pay for it. It is not rare to find dealers who even insist on "cash payment" when selling a second-hand machine.

In the international business for second-hand machinery it is also often found that the trading companies that are active are those that sell new machinery. However the biggest turnover in second-hand machinery is achieved by trading companies that have specialised in second-hand appurtenances and equipment.

As the dealers' networks of contacts play a special role in the trading of second-hand machinery, some of the trade in second-hand machinery does not apparently take place directly, but through "hubs“ of international trade. Thus many machines are sold via Finland to Russian, via Greece to Eastern Europe, via Turkey to the Middle East and via the USA to Central and South America. In Germany there are roughly 3000 dealers of second-hand machinery and equipment. They have organised themselves in associations such as the Association of German Exporters (BDEx) and the Special Association of German Machinery Trading (FDM). There are similar organisations in other industrialised countries. This rarely tends to be the case in developing countries.

Thus the relatively large number of small dealers make the market difficult to assess and difficult to grasp in terms of statistics. Incidentally, the dominance of machinery dealers also highlights problems that the acquisition of data on the export of second-hand machinery involves.

2.2.2 Users of the machinery / industry

The users of machinery, i.e. the industrial enterprises themselves, play a subordinate role in international trading in second-hand machinery and equipment. This may have various causes:

- For **image reasons** industrial enterprises do not like to be perceived as being involved. This is particularly true for the target sectors of this study. For this reason there is usually no data officially available from the operators for second-hand machinery or entire installations that pollute the environment.
- Industrial enterprises are not fully aware of the **market value** of their machines abroad or are not able to successfully handle sales. They therefore hand over the job of selling the machines to experts (dealers and service providers). This strategy is probably of importance for medium-sized companies.
- A relatively high percentage of the machinery originates from **companies that have gone into liquidation** and this is dealt with by dealers and service providers.

- Companies sell machinery that is no longer used back to the **manufacturers of the machines**. These then clearly appear as suppliers of second-hand machinery.

The low proportion of manufacturers and users now in the business for second-hand machinery already represents a clear change in comparison with the 1990s when it was almost only dealers who were active. The possible profit margins seem to be too high for this business to be left to dealers alone.

There are also clear signs that **large-scale industry** is interested in profitably selling its second-hand machinery abroad. It is obvious that the most varied sales channels are used. Some examples:

- "Infraserv Hoechst“ is an internet platform that offers second-hand equipment and apparatus for sale and it is likely that it also has equipment from Höchst and Aventis in its range of products.
- Various businesses in the large-scale chemical industry have already exhibited at the RESALE (interview with Hess GmbH).
- ThyssenKrupp, Henkel, ABB, SKF and Babcock Borsig Power are reference customers for the internet platform, Surplex.com.
- DaimlerChrysler is a customer of the auction house, Dovebid.

Sales channels	Examples	Indications of big German industry
Virtual marketplaces	Surplex, Machinestock, surplusglobal	Reference customers: ThyssenKrupp, Henkel, ABB, SKF, Babcock Borsig Power
Auction houses	Angermann & Lüders Dovebid	Mainly bankruptcies of medium-sized companies Reference customer: DaimlerChrysler
Trade fairs	RESALE	Large-scale chemical industry as an occasional exhibitor
Specialised internet platforms	Infraserv Hoechst, Lohrmann	Aventis, Various operators of power stations
Direct contacts / dealers	List of all BDEx exporters	Various reference customers in large-scale industry

Figure 2.3: Sales channels for second-hand machinery and equipment and indications of the behaviour of large-scale German industry

Apart from this, big industry now uses second-hand machinery and equipment in the form of **investments** as a low-cost way of testing the market or opening up a market (e.g. the steelworks of Hoesch in Nigeria). This could particularly be the case with the target sectors of this study.

2.2.3 Manufacturers

For manufacturers of machinery the market for second-hand machinery is mainly a means of winning **customer loyalty**. As with trade in second-hand vehicles they are now accepting the return of used machinery provided that the customers purchase a new machine. The used machines are then often sold to developing countries and emerging markets. In this a **new market segment** is also opening up for manufacturers of machinery. .

Even the sale of a second-hand machine to less developed countries can lead to customer loyalty in the long term. As the example of the Republic of Korea has shown, companies that were buying second-hand machinery 20 years ago are now customers for new machinery. As the demand for German second-hand machinery usually exceeds supply in many sectors, the marketing effort and the concomitant costs are kept within limits. Even medium-sized manufacturers of machinery have now appointed sales managers for second-hand machinery. Stoll, for example, a manufacturer of textile machines, sells new machinery to industrialised countries and second-hand machinery to developing countries and emerging markets, particularly to Eastern Europe.

2.2.4 Service providers

A number of services have sprung up around the trade in second-hand machinery which highlight both the **relevance** as well as the **complexity of the market**. Apart from this, it can be seen that customers for second-hand machinery have become increasingly demanding during the course of the years as regards the quality of the goods and services. Thus now not only machinery with a seal of quality (e. g. from the Association of the German Machine Trade FDM), certification (for example from TÜV Nord) and guarantees are offered, but also innovative ideas for the provision of finance and services that facilitate matters such as storage, transport and maintenance.

Services concerning the business of second-hand machinery

- Financing concepts (leasing)
- Integration of used and new machinery
- Auctions
- The recycling of plants
- Guarantees
- Seals of quality, certification
- Insurance / transport
- Storage
- Handling sales / Export of goods
- 24-hour service
- Repairs / reconditioning
- Assembly / dismantling
- Maintenance agreements
- Supply of spare parts
- Expert opinions / evaluations / return on investment analyses
- Advice in matters of asset management

Normally machines are sold in an "as it is" condition, but now trading companies are increasingly willing to completely or partly recondition the machines and to grant guarantees. Customer for second-hand machinery are also increasingly able to enforce specific requirements and, for example, to demand the integration of second-hand and new elements of machinery or an adaptation to the circumstances at the new location. It is interesting to note that even the general reconditioning of second-hand machinery is already being outsourced to countries such as the Czech Republic. This is partly for reasons of costs. But

services are also available to the seller of second-hand machinery and equipment which are mainly composed of various consulting modules..

Sometimes these services are offered by manufacturers or machinery dealers to support the trade. Usually, however, service providers are specialists in their field who have recognised second-hand machinery and equipment as a lucrative market segment and have sometimes even specialised in second-hand machinery. The various service companies are optimistic as regards the future of the industry. Thus the head of the specialist company in Nuremberg, IS, which has already handled 150 turn-key "relocations“, expects that "moving even large-scale production installations around the globe will become something that goes without saying". The engineering company Krupp Uhde also sees "an interesting business opportunity in the relocation of larger and more complicated plants" (Weishaupt).

A summary overview of the reasons for the export of second-hand machinery and equipment and the motivation of the individual parties involved can be found in chapter 5.1.

2.3 Market information on second-hand machinery and equipment

The proportion accounted for by second-hand machinery in the total sales of machinery in **Germany** is not known, but experts estimate it to be 3 to 5 per cent. The tendency is obviously increasing strongly and in a few years the proportion could account for as much as 30 per cent (BDEx). Equipment that can be used in the long term (wood machines, machine tools or machinery for plastics) already accounts for 15 per cent and more. The proportion of second-hand machinery among paper, packaging and food machines, on the other hand, is below average.

A few experts have tried to estimate the total size of the market for second-hand machinery and equipment. The estimation for Germany is an annual turnover of **€ 10 to 15 billion** (BDEx, HWWA). Most second-hand machinery and equipment originates from modernisation measures, factory conversions or from factories being shut down. Second-hand machinery and equipment from Germany has an outstanding reputation in nearly all countries and regions. In many markets demand even exceeds supply. An estimated 50 per cent of all second-hand machinery and equipment that is sold is therefore shipped abroad.

For the entire area of the **European Union** the bfai estimates the total market for second-hand equipment at € 45 billion. The Dutch foreign trade service, EVD, is even more optimistic and estimates the market to have a magnitude of € 76 billion. The biggest individual market is the **USA** where trade in second-hand machinery and equipment has a long tradition. The annual volume there is estimated at more than € 40 billion (bfai). Very optimistic estimations put the figure much higher: "*The worldwide industrial asset industry generates an estimated $1 trillion*" (Online Asset Exchange, San Diego Business Wire, November 9, 2000). The various estimations may have a high degree of imprecision, but it is highly likely that each year second-hand machinery and equipment to the value of more than **€ 100 billion** is sold throughout the world. A large part of this goes to developing countries and emerging markets.

In order to obtain a more precise insight into the structure and the size of the market, various

internet platforms that are concerned with trade in second-hand machinery and equipment will be analysed below. As already indicated, the internet, with its versatile potential for design and presentation, presents a suitable medium for the global sale and procurement of second-hand machinery and equipment. A distinction must be made between a number of different internet offers which are of relevance. So-called **online market places** are very widespread. Here it is mainly dealers who offer their machines for sale. This is usually done across sectors and without any narrow geographical focus. These platforms include Surplusrecord.com, Buyused.com, Surplex.de and others. Second-hand machinery and equipment on offer is catalogued in modern databases.

Platform	Country	Description	Orientation	Number
Surplusrecord.com	US	Biggest online marketplace for second-hand machinery, 1000 dealers	cross-sector	56,000
Buyused.com	US	"used equipment network" – internet catalogue	cross-sector	76,000
Gebraucht-maschinen.de	EU	MM industrial magazine MCW-UK	Focuses on WZM	20,000
Machinestock.com	Germany	FDM Association - service for members	Focuses on WZM	12,000
Surplusglobal.com	Kor	Union of various Korean associations	cross-sector	16,600
Surplex.de	Germany	Internet marketplace with numerous partnerships	cross sector	10,000
Netbid.com	Germany	Angermann Lüders (auction houses), Deutsche Leasing AG	cross-sector	1,000
Dovebid.com	world	Auctions / liquidations	cross-sector	no figures
Assettrade.com Goindustry.com	world	Internet platform, auction house, service provider	cross-sector	10,000
gebraucht-apparate.de	Germany	Second-hand apparatus (Hoechst-infoserv)	from own production	500
LCEC.com	US	Louisiana Chemical Equipment, internet platform, service provider	complete chemical plants and components	14,600
Lohrmann.com	Germany	Specialist for second-hand power stations (1-1000 MW)	Power stations (approx. 20) and power station components	500
RESALE trade fair	World	Hess GmbH, biggest trade fair for second-hand machinery and equipment	cross sector, specialising in WZM	150,000

Figure 2.4: Overview of the most important internet platforms and the number of suppliers

A second important group of service providers who use the internet as a marketing channel are **auction houses** for second-hand machinery and equipment. These include Dovebid.com, Netbid.com and Assettrade.com. Auction houses often auction complete factories and inventories from the estates of bankruptcies or from leasing companies. Finally there is also a number of **internet offers that are specific to certain sectors** such as LCEC.com or Lohrmann.com. On some platforms here and there large-scale industry also appears on the internet as a supplier of its own discarded machinery and equipment. Finally publishing houses, trade fair companies and other relevant institutions use the internet as a **communication platform**.

It is important to note that it is mainly through the internet that markets shift or lose their borders due to electronic communication. The actual origin of the machinery and equipment on offer can therefore only be ascertained by carrying out detailed research.

Figure 2.4 shows the most important platforms and also indicates how many machines or pieces of equipment are currently on offer on the individual platforms. The average price achieved for each machine sold at online marketplaces lies at around 60 to € 70000[2]. The price achieved at auctions averages € 1 million[3]. With these figures it can be extrapolated that the platforms listed here alone currently offer second-hand machinery and equipment to the tune of more than **€ 40 billion**. This shows on the one hand that a decisive part of the trade in second-hand machinery and equipment is covered by the platforms. On the other hand this figure roughly coincides with the above-mentioned estimations made by the experts.

The data of the various internet platforms, however, can be evaluated in even greater detail. Thus an analysis carried out by Netbid, Surplex, Goindustry and AssetTrade resulted in the following distribution across sectors for the second-hand machinery and equipment on offer (figure 2.5).

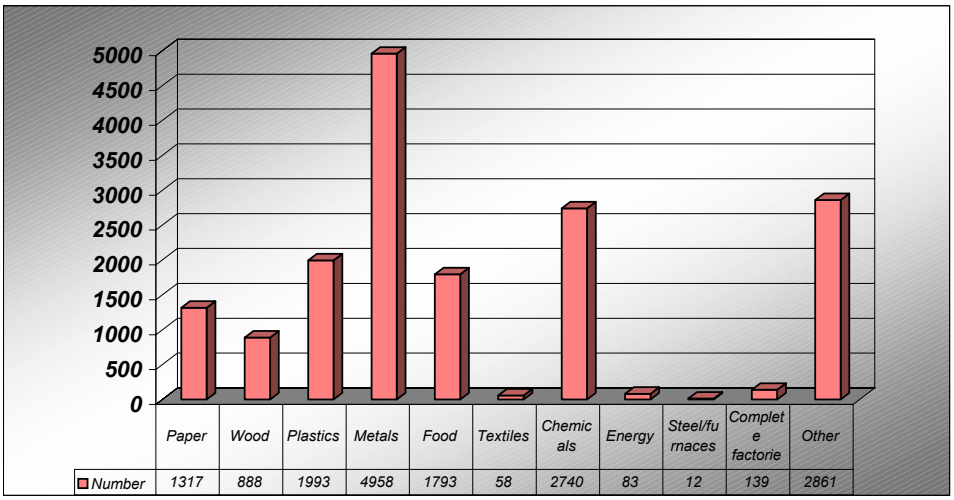

Figure 2.5: **Distribution across sectors of the second-hand machinery and equipment offered at online market places**
Source: Netbid, Surplex, Goindustry, AssetTrade

As was to be expected, machinery for the processing of metals (machine tools), food machines, machinery for plastics, paper machines and wood machines are the sectors that are way ahead. The large number of machines offered in the chemical sector is due to the fact that a great deal of low-value laboratory equipment is recorded here. It seems that at the online market places the machinery marketed is primarily machinery that does not belong to the critical industrial sectors in the meaning of this study. For this reason chapter 2.7 contains further analyses of second-hand machinery and equipment in sectors that have a particularly polluting effect.

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[2] AssetTrade: a turnover of € 600 million with 10,000 machines - Online Asset Exchange (USA) is planning on brokering 200,000 plants to Central and South American at a price of € 14 billion.

[3] Dovebid: a turnover of € 5 billion at 5,000 auctions

So far the possible transfer of second-hand machinery and equipment to developing countries and emerging markets in the context of **foreign investments** has only been mentioned on the side. Unfortunately no reliable data could be gathered in this area. Individual indications, however, give reason to believe that second-hand machinery and equipment is sometimes also used in the target sectors. In view of the volume and the growth of German investments in the countries of destination a large number of second-hand goods are exported in this context as well. This particularly concerns countries such as China where, for legal reasons, foreign investments are the most usual method of implementing second-hand machinery and equipment.

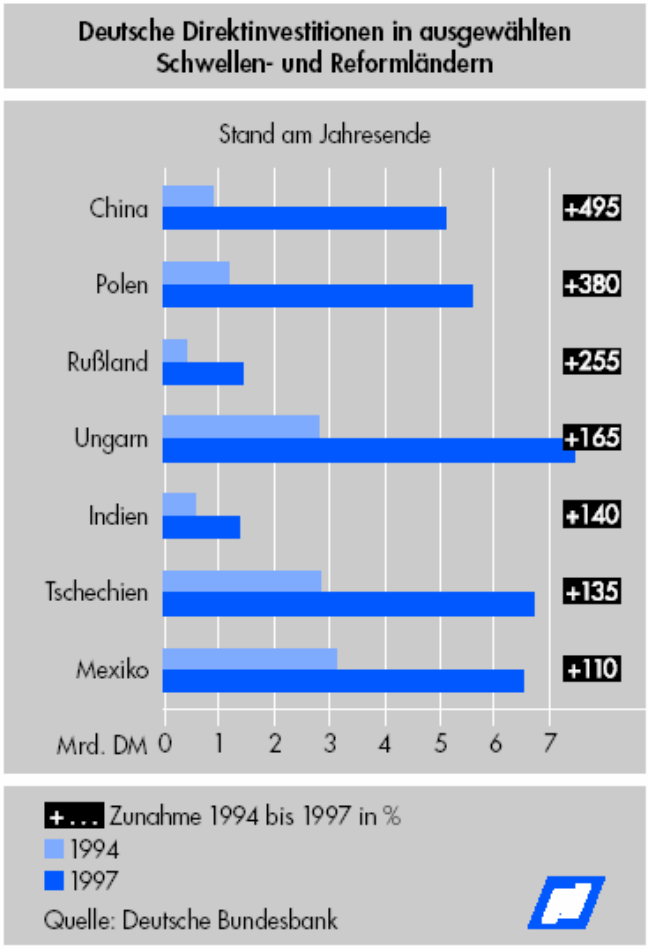


Figure 2.6: **German direct investments in selected emerging markets and reform countries**
Source: German Bundesbank

2.4 Indications as to the quality of second-hand goods and equipment

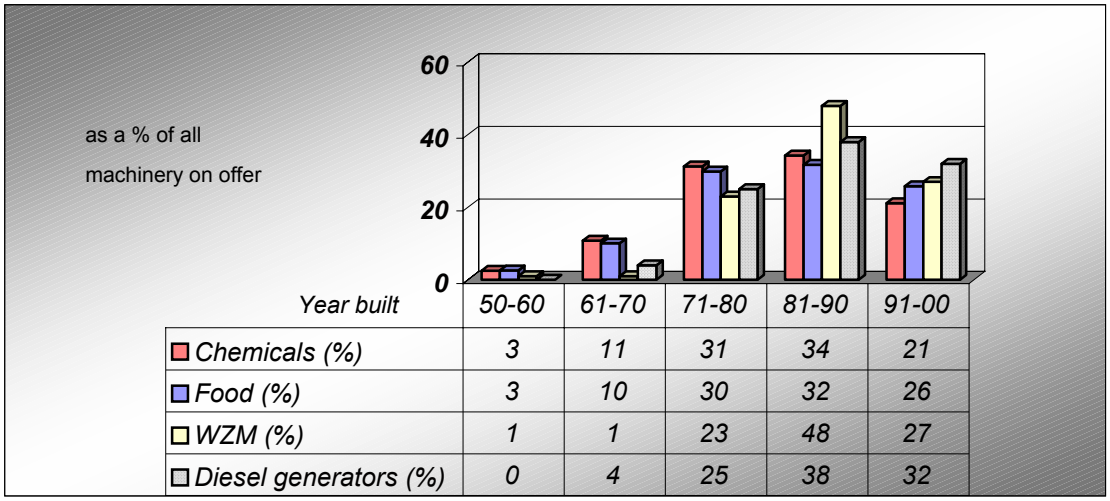
The Association of German Wholesalers for Machinery and Tools (FDM) has not only introduced a **quality classification system** for second-hand machinery and equipment, but also ascertained the quality of German second-hand machinery and equipment. According to this classification, more than half of the machinery on offer is still in very good condition (figure 2.7).

	Quality	Percentage
A	New from the factory	3%
B	New and not used	2%
C	As good as new	12%
D	Very good	35%
E	Good	32%
F	Useable	16%

Figure 2.7: The quality of German second-hand machinery and equipment
Source: FDM, 2002

The **age structure** also plays an important role with regard to the estimation of the environmental impact. This is because it is only on the basis of this information that the technical condition of the goods at the time of export can be ascertained. As figure 2.8 shows, the age structure depends only slightly on the industrial sector. Thus machinery from the food industry tends to be newer than machinery from the chemical industry. A trend can be observed, namely that **second-hand machinery and equipment for export is usually between 10 and 20 years old**. However it has turned out that from the point of view of the customer the age of a machine is not always decisive. Experts report that even equipment that is as much as 30 years old is nevertheless purchased. Machinery from the 1970s and 1980s is often much more robust than new machinery and offers greater stability and more favourable static conditions. Such conventional machinery is suitable, for example, for medium-sized companies that have specialised in largely identical individual parts or in smaller series.

As the lifetimes of machines are becoming shorter and shorter, second-hand machinery and equipment today is more modern than it was a few years ago.



Year built	50-60	61-70	71-80	81-90	91-00
Chemicals (%)	3	11	31	34	21
Food (%)	3	10	30	32	26
WZM (%)	1	1	23	48	27
Diesel generators (%)	0	4	25	38	32

Figure 2.8: **The age structure of second-hand machinery and equipment depending on the industrial sector**
Source: goindustry, September 2002, other internet platforms

2.5 Typical problems in the export of second-hand machinery and equipment to developing countries and emerging markets

The international trade in second-hand machinery can involve problems which seem to be specific to this sector. These problems either occur on **use in the new location** or they are connected with **trade practices**.

Even if second-hand machinery may seem to be a low-cost alternative for companies in the countries of destination, their transfer is not always unproblematic and their use does not always (immediately) provide the desired results. This is partly to do with the machinery itself, which has usually been constructed under the **conditions of developed nations**. Typical problems, for example, are technical difficulties occurring as a result of different climates. Thus it may become necessary to install a cooling element in the process in certain places or equipment may prove to be so sensitive that it can no longer function properly without expensive protection devices. Apart from this, necessary resources may be missing or the existing resources may not have been exhausted. A further point is that the machinery's high degree of automation often causes serious problems for workers in developing countries and emerging markets, at least in the initial phase.

There is also a number of constantly recurring problems which seem almost trivial, but which may cause high and unexpected costs. These include, for example, the absence of spare parts or machine plans.

Special buyers' wishes and expectations often cause problems as well. Thus a second-hand refinery transferred from Germany to India had to be reconstructed in a time-consuming

process so that the capacity of the plant was increased and diesel could be produced instead of petrol.

The seller's leading edge in information

A comparison or a loan of a theory from the field of the export of second-hand vehicles seems appropriate. The "**Lemon Model**" is based on the assumption that sellers of second-hand automobiles have a certain leading edge in information vis-à-vis the buyers. According to the model, the consequence is that the quality of the vehicles sold is below average. Detailed investigations in Basle have in fact supported this theory. With regard to the present problem, it would be interesting to investigate whether similar considerations can also be made as regards international trade in second-hand machinery and equipment, i.e. whether buyers in developing countries **tend to buy products of below-average quality**. Some initial indications have been obtained. Thus bfai reports of fraudulent practices in Egypt where dealers fail to tell buyers about technical defects in the machines (see also Arrows: "In each transfer there is an inherent asymmetry between buyer and seller").

But the market structure mentioned in chapter 2.2 also involves a basic problem for the trade. Although dealers are increasingly specialising in certain products, they have not usually operated the equipment themselves and are not familiar with the details required to guarantee a smooth transfer. In addition to this, dealers are usually concerned with maximising their profits, i.e. they wish to sell their machines as fast as possible. Sometimes even fraudulent practices can be observed among the less trustworthy companies which are mainly to the detriment of small companies with little financial clout. These companies usually work with forged documents and inaccurate pricing. Apart from this, transport abroad often takes unusual routes, the machinery being shipped with other consignments. The situation is usually different when manufacturers or operators sell a machine or a piece of equipment.

Unlike machinery dealers, users know their machines very well. Sometimes they have even helped to develop the machines or have developed them further. In a sales situation they are therefore much better able to support the integration of the machine into the new environment.

2.6 The status of second-hand machinery and equipment in the countries of destination (analysis of countries)

In developing countries and emerging markets second-hand machinery and equipment from industrialised countries sometimes plays an extremely important role. The reasons for this are obvious. In many growth markets there is a serious **need for the renewal and expansion of investment goods** when indigenous production is expanded. In comparison with their own, sometimes outdated machinery and equipment

Proportion of second-hand machinery :

- In some countries 20% is second-hand machinery (even higher in Africa)
- Morocco, up to 35% of the market for machinery
- Brazil 3%
- Thailand: 90% of textile machines are second-hand
- India: 75% of all imported capital goods are second hand (IMI-US Gov)

second-hand machinery and equipment from industrialised countries usually means great technological progress. Low investment costs, rapid availability and low conversion effort are often more important in developing countries and emerging markets than modern labour-saving technologies which are also possibly complicated and susceptible to faults. As far as the complexity and the **quality** of the technology in demand is concerned, there is, according to bfai, a clear correlation with a country's level of development. A high-tech machine will sell more easily in Poland than in the Ukraine, for example. The situation is precisely vice-versa as far as **quantity** is concerned. Thus Navaretti shows that the proportion of second-hand imported machinery in a country declines as the level of development rises. The level of development is defined in terms of income per capita, the level of education and average wages. There are often reservations about second-hand machinery and equipment in places where the ultimate consumer is strongly geared towards exports. The volume of imports heavily depends on the business situation and the legal conditions in the countries of destination.

As a regional breakdown of the visitors to RESALE 2002 in Nuremberg shows, in Eastern Europe there is particularly great interest in second-hand machinery and equipment from Germany. Most visitors to the RESALE exhibition were from Romania, the Ukraine, Russia, Iran, Turkey, India, Lithuania, Nigeria, Egypt and Tunisia. It would seem that with the second-hand machinery typically on display at trade fairs, machine tools, packaging machines, food machines and machinery for plastics, it is buyers from developing countries and emerging markets that are **relatively close in geographical terms** who are looking for second-hand machinery and equipment.

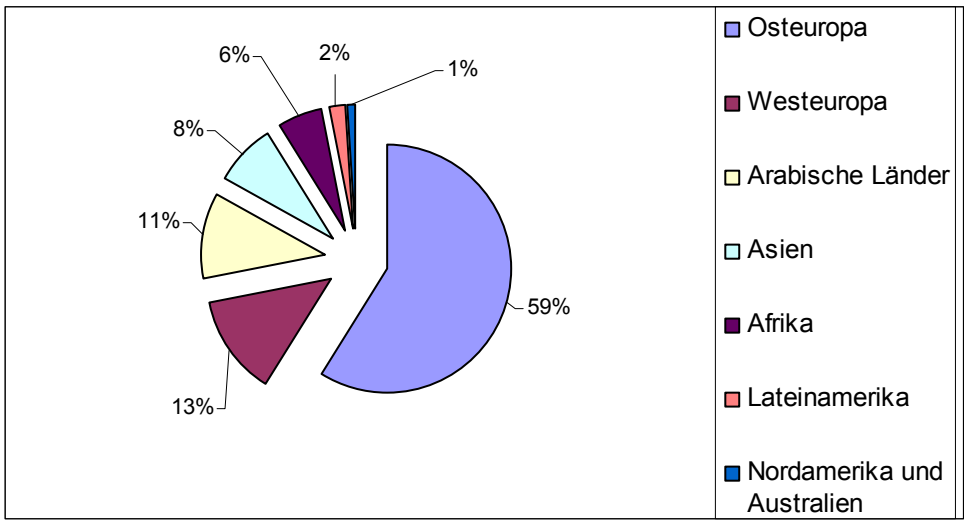


Figure 2.9: A breakdown of the visitors to RESALE 2002
Source: Hess GmbH, 2002

Country	Market data and focal sectors for second-hand machinery and equipment in the countries of destination
Brazil	Imports of second-hand machinery: 200-400 million US$ per annum. 3% of all imported machines are second-hand. Tool machines, chemicals, steel, textiles, printing and packaging.
India	The building trade, tool machines, plastics, refineries, packaging, printing, mining, chemicals. 75% of all imported capital goods are second-hand.
Indonesia	Textiles, mining, the wood industry, the food industry, energy, paper In 2000 state-owned testing companies recorded a 35 % increase in their business One in every two machines purchased by the leather industry is second-hand.
Morocco	Double-digit rates of growth since 1998. The market leader in German second-hand machinery . 35% of all imported machines are second-hand. Imports of second-hand goods of approx. 1 billion US$. Textiles, the leather industry, the food industry, medical technology, the construction industry .
Mexico	Free trade agreement with the EU since 2000, "Industria Maquiladora de Exportacion“ encourages the trade. Total turnover: 900 million US$ (1999). Packaging, tool machines, the wood industry, chemicals, food processing, textiles, garments and the leather industry
Russia	The generation of energy, the processing of mineral oil, food, agriculture, the building trade, machinery for plastics, wood processing and, to a lesser degree, textiles, garments and tool machines

Figure 2.10: Market data and focal sectors for second-hand equipment and machinery in some of the countries of destination

A look at the individual target markets affords an insight into the specific countries. In view of the relative self-contained character of the market in recent decades the machinery of Brazilian producers is outdated and highly inefficient. At the end of the nineties **Brazil** purchased second-hand machinery to the value of between 300 and 400 million US$ each year. According to official statistics, machinery to the value of only 200 million US$ was purchased in 2000. In addition to cyclical downturns, the main reason this probably brief slump is probably the 40 per cent increase in the cost of imports, which is linked with the price fluctuations. Experts estimate that the growth of machinery imports will behave in the same way as the growth of imports of second-hand machinery (bfai), which is usually twice as high as the growth in GDP. Whether the import structure of second-hand machinery and equipment also reflects the structure of the economy is something that cannot be said in Brazil on the basis of the available data, as in all other countries. In the case of imports of machinery it is noticeable that the market position of Europeans is strong, particularly for "non-electric machines". This is true both as regards the volume and as regards market share. Similar assumptions can be made for second-hand machinery and equipment in this area.

In **China,** although there is theoretically a strong demand for second-hand machinery, the heavy regimentation of imports of second-hand goods should ensure that second-hand machinery and equipment will only enter the country in the context of investments. However these are very high in China. If only 5 per cent of the machinery and equipment imported to

China in 2000 were second-hand, this would nevertheless correspond to a value of almost five billion US$. In view of the fact that it has its own investment goods to the value of an estimated 60 billion US$ that are lying waste, the People's Republic has a great interest in itself becoming a global supplier of second-hand machinery and equipment.

A quarter of all **Indian** imports are investment goods. In the estimation of the US Commercial Service, three quarters of these imported investment goods are second-hand (International Market Insight for India, "Import of used equipment“). The activities of Indian dealers in second-hand machinery and equipment on the Internet, which is above average, indicate that the country's economic growth is largely based on second-hand machinery.

In order to make the growth of Indian industry apparent in the target sectors, the production volumes of various products between 1995 and 2001 were compared. As is shown, the production volume, and thus probably production capacities as well, have grown considerably in only six years at 22 per cent (paper) and 83 per cent (refinery products). In the field of energy generation this roughly corresponds to a growth in power station capacities of 23 GW. It would seem that a large part of these capacities is based on second-hand machinery and equipment.

Another factor which should be mentioned is the poor condition of Indian industry. Thus the energy-intensity of Indian cement production, for example, is between 20 and 50 per cent higher than on an international comparison, depending on the type of process. Similar figures are to be found in other energy-intensive sectors such as the production of steel or aluminium (Ahuja). Annex 2.1 provides further information about energy-intensive sectors in India and indicates some possible potential for making savings.

Industry	Unit	Production in 1995	Production in 2001	Change in capacity
Crude steel	million tonnes	16	27	+11 (+70%)
Aluminium	thousand tonnes	467	620	+153 (+33%)
Cement	million tonnes	62	99	+37 (+60%)
Refinery products	million tonnes	53	97	+44 (+83%)
Paper / cardboard	thousand tonnes	255	310	+55 (+22%)
Electricity	million MWh.	350	499	+149 (+43%)

Figure 2.11: The growth of various sectors in India between 1995 and 2001
Source: relevant Indian ministries (2002)

A set of statistics that shows the number of new factories (that may also have been built up primarily on the basis of second-hand machinery) completes the picture of the growth of Indian production capacities in the various industrial sectors.

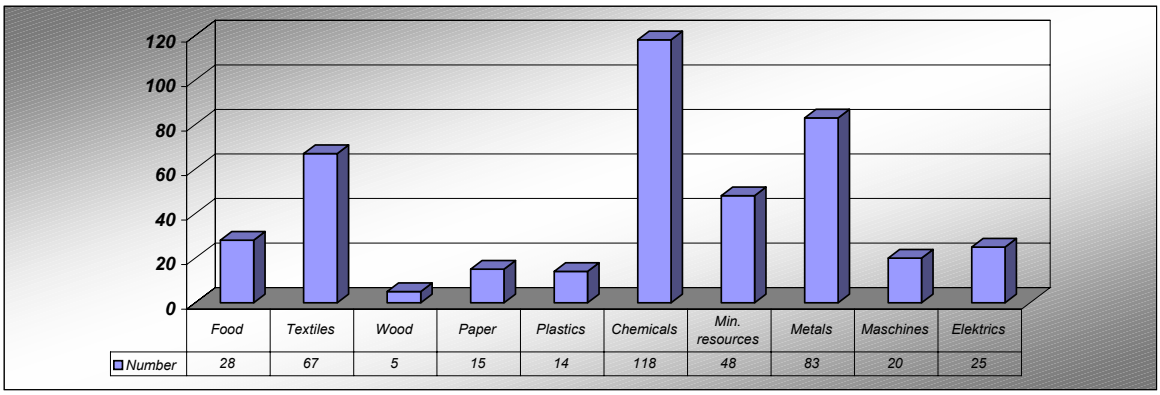


Figure 2.12: The number of new installations each year in India
Source: "Does environmental legislation", Muthukumara Mani, February 1997, The World Bank

The biggest demand for second-hand machinery in **Indonesia** is in the textiles, food and packaging industry. The textiles industry alone, which is heavily geared towards exports, imports half of its machines second-hand. Second-hand heavy-duty equipment for mining, the construction of power stations as well as forestry and the plantation industry also finds buyers in Indonesia. Other notable customers are the food and beverages industry and the printing trade. The main country of delivery is Japan, followed by emerging markets of Asia, some of which relocate entire factories, and Europe which mainly exports individual machines. State-owned testing companies commissioned with the technical inspection of the imported second-hand goods recorded a **30 to 40 per cent increase** in their business in 2000 (bfai). Most of the second-hand capital goods do not enter the country in a reconditioned state. In 1996 the Indonesian government actively looked for used refineries of between 20 and 80 TBPD in the USA and Canada (United States Energy Information Administration, February 1997).

In **Morocco** imports of second-hand machinery and equipment have shown double-digit rates of growth since 1998. This growth has meant that now 35 per cent of all imported machines are second-hand. In 2001 this corresponded to roughly one billion US$. German suppliers of second-hand machinery and equipment are the market leaders according to bfai. The focal sectors for second-hand machinery and equipment are the textiles and leather industry (second-hand imports of € 33 million). They particularly need machines to produce woven fabrics and yarns and also for processing leather. Second-hand machinery and equipment from the food sector also have good chances of success in Morocco. What seems important in this context is the fact that under the Mediterranean Treaty a common economic area for industrially manufactured goods is to be established by 2012. At present there are about 6,000 companies that are candidates for modernisation through second-hand machinery and equipment.

In 1999 the **Mexican** market for new and second-hand machinery was worth almost 900 million US$ (US Commercial Service - International Market Insight). About 50 per cent of this is supplied from the USA. German suppliers obviously have good chances in the case of machinery and equipment in for metal processing, chemicals, printing, paper, food processing, textiles, garments, shoes and leather goods (bfai). The Free Trade Treaty concluded with the EU in June 2000 also benefits the strong demand for reliable and more

low-cost second-hand machinery. A particular characteristic of Mexico is what is known as the "Maquiladora“ industry, close to the border with the USA which enjoys a number of tax privileges. This industrial area, which has existed since 1965, has grown by 20 per cent a year since the introduction of NAFTA. In view of its proximity to the USA, the few environmental rules and the wages that are 10 to 15 per cent below those in the USA, it is predestined for relocations from the USA. This is an area where second-hand machinery and equipment is used. As has been shown, the 3,000 companies now in this area have a very adverse impact on the environment. Thus every year, for example, almost 400,000 m^3 of untreated waste water flow into the Rio Grande. It remains to be seen whether a similar development will take place in Poland in view of its forthcoming accession to the EU.

Countries such as **Hungary, Poland, the Czech Republic, Slovakia and Slovenia** mainly require second-hand machinery and equipment that is not so old as they increasingly wish to export their products to western Europe and they must therefore meet a relatively high standard of quality. At the same time these countries now even export their old machinery to countries lying further to the east. The proportion of second-hand machinery in the entire stock of machinery is estimated to be 10 to 20 per cent. The energy intensity of Polish industry is three times higher than the average in the European Union.

Russian industry has also expressed a great interest in second-hand machinery and equipment. About 70 to 90 per cent of Russia's industrial production basis is outdated (Verteyko). At present most second-hand machinery and equipment is used in the sectors food, agriculture, construction, machinery for plastics and wood processing and, to a lesser extent, in textiles, garments and machine tools (bfai). It can be assumed that in view of the lack of financial resources an estimated proportion of 30 to 50 per cent of second-hand machinery that has not been reconditioned will find its way into the country. The fact that international internet portals now have an option in the Russian language and maintain contact offices in Russia can be seen as a further indicator for the market opportunities of second-hand machinery and equipment in Russia. According to details provided by the country, Russia has a particularly high demand in the energy sector. By 2020 more than 350 billion US$ are intended to go into refineries and power stations and many used refineries have already been sold to the countries of the Russian Federation (see also Annex 2.2). The consortiums of Shell and Exxon-Mobil will probably invest eight and four billion US$ in Russia in the next few years.

Sector	2000	2001-2005	2006-2010	2001-2015	2016-2020	Total
Refineries	4.7	19-21	23-31	31-44	41-48	115-145
Power stations	1.6	18-19	25-42	44-69	61-87	147-217

Figure 2.13: Investment requirements in Russia - energy sector (in billion US$)
Source: “Energy Strategy of the Russian Federation to 2020” (MinEnergo, 2001).

The **South African** market for second-hand machinery is divided into two parts. While modern, export-oriented companies dominated by whites hardly use any second-hand machinery or equipment, the businesses of many black entrepreneurs are based on imported second-hand machinery (bfai). It should be emphasised that South Africa has now become

the marketplace for second-hand machinery and equipment in southern and eastern Africa.

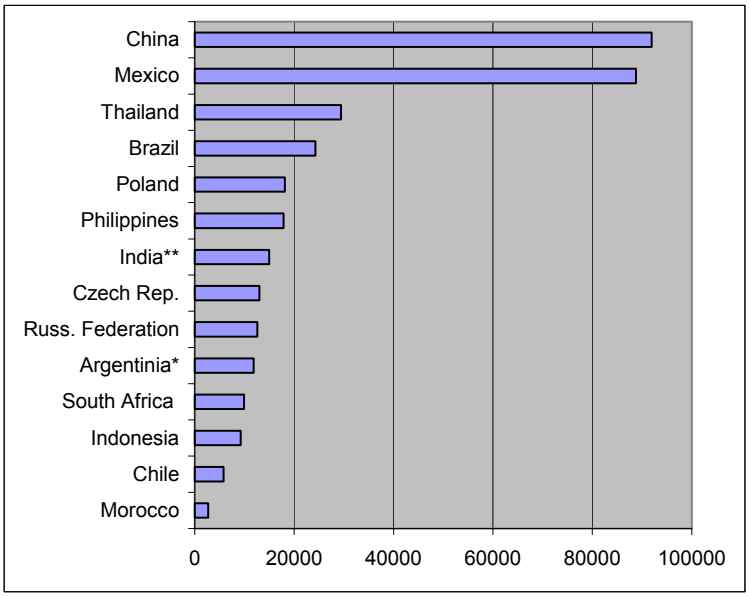


Figure 2.14: Imports of machinery and transport equipment of selected economic systems, 2000 - *figure for 1999, **estimated figure, Source: WTO, "International Trade Statistics 2001"

The total imports of machinery and transport equipment to the 14 most important developing countries and emerging markets amounted to more than 350 billion US$ in 2000. If one takes account of the legal conditions and of the various different factors in the individual countries (i.e. the relatively high proportion of second-hand machinery in India or Morocco, the relatively low proportion in China), it seems more than likely that second-hand goods with a value of **at least 50 to 60 billion US$** were exported to these countries alone in 2000 (basis 15%). Whether the import structure of second-hand machinery and equipment also reflects the structure of the economy cannot be said on the basis of the data currently available.

2.7 The status of second-hand machinery and equipment in the target sectors (analysis of sectors)

2.7.1 General considerations

A possible approach to qualitative statements concerning the export of polluting second-hand goods in the target sectors is the interpretation of structural changes. These are described in academic studies and research into sectors that cause pollution. Jänicke, for example, researches the development of 11 primary industries and the generation of electricity in 32 industrialised countries since 1970. The list of the industries investigated is largely identical with the focal sectors of this study. Although Jänicke is concerned with different questions, the results allow conclusions to be drawn concerning the role of the export of second-hand machinery in this connection:

1. **End-of-the-pipe technologies** are part of the industrial standard in most industrialised countries. It can therefore be assumed that much of the second-hand machinery and

equipment for sale today is also equipped with these technologies - provided that they have been in operation at all, have not been out of operation for too long a time and their transfer and use do not involve heavy additional costs for the buyer. In 1970, by contrast, additional investments in end-of-the pipe technologies which had become necessary due to stricter environmental legislation were often the driving force behind the relocation of factories to developing countries.

2. The structural changes that can lead to a long-term reduction in material intensity include:

- the growing importance of the service sector,
- the growing environmental awareness of consumers (post-materialism) ,
- the declining consumption of primary materials in the manufacturing industry (cost-cutting modernisation),
- the decreasing material intensity of the primary industries themselves,
- the substitution of various materials (natural oil by gas, metal by plastic etc.)
- the price of oil,
- economic crises.

It is likely that the structural changes described above are also of importance for the export of second-hand machinery and equipment as **capacities that become free** are possibly being relocated to fewer developed countries.

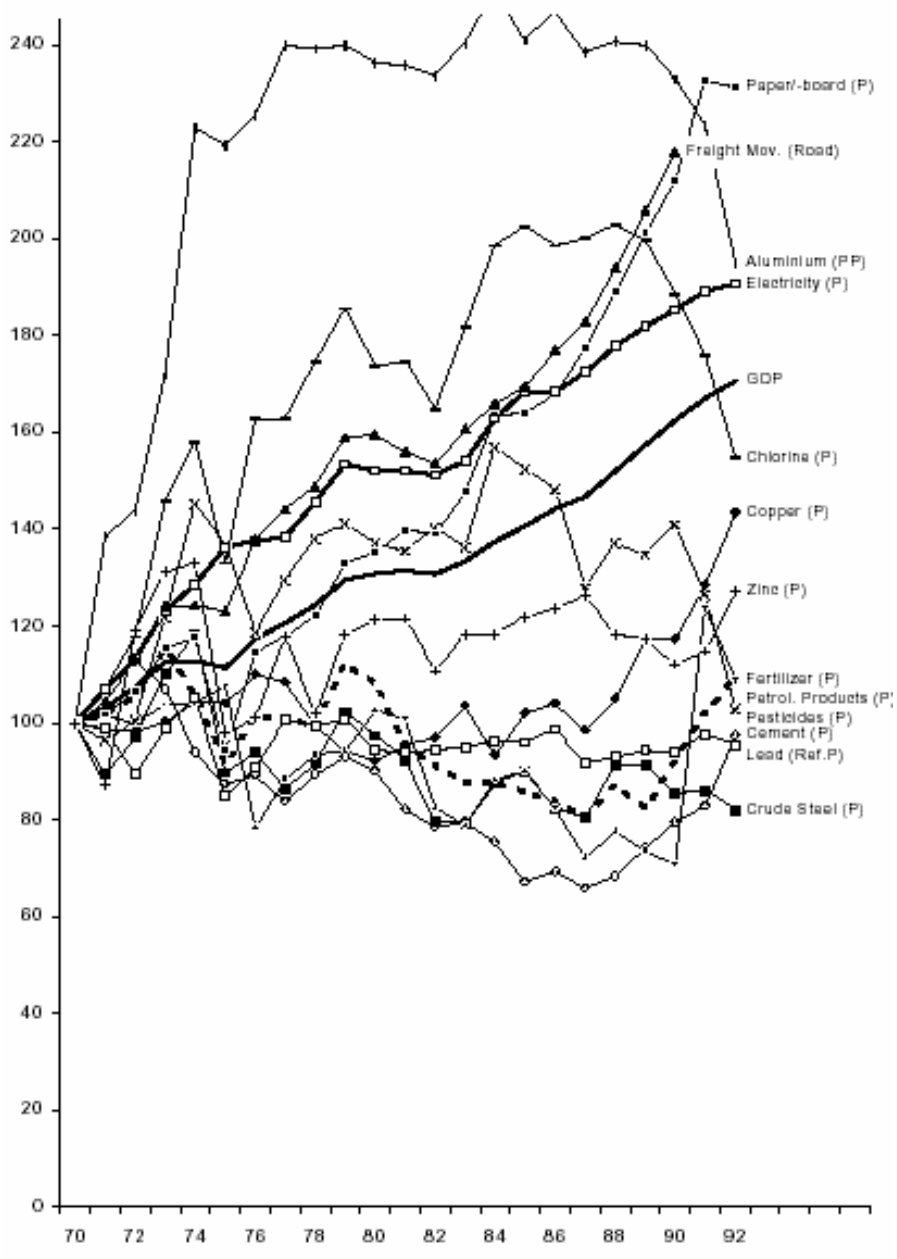


Figure 2.15: Structural changes in Germany (1970 = 100)
Source: Jänicke, 1996

3. The **modernisation of production systems**, which in the past was particularly predominant in sectors that pollute the environment, can provide a decisive stimulus to the export of second-hand goods. In 1987 the Japanese chemical industry used about 16 per cent less energy in comparison with 1971, 31 per cent more water and 13 per cent more land. At the same time, however, the value of the goods produced has risen by 151 per cent. It seems obvious that such fundamental changes can also come about through the exchange of equipment or equipment components and thus second-hand investment goods have been put on the world market.

2.7.2 The processing of mineral oil

Second-hand refineries are sold as whole refineries or in components. Wolfgang Rohde from

Mobil-Oil suspects that there are currently "**surplus capacities in the European refinery business of 50 to 100 million tonnes a year**". These are capacities that could be used again in a developing country or emerging market.

Probably the best known example is the transfer of a complete refinery from Germany to India organised by the engineering company, Krupp Uhde. The project seems to have been a good bargain for both sides as the German mineral oil group **avoids the costs for scrapping** its plant while at the same time pocketing the sales proceeds. The Indian buyer gets a complete refinery for around 600 million dollars (including transport). It would have had to pay twice as much for a new plant. The scale of the **cost savings** seems typical of the sector. It is reported, for instance, that the relocation of a refinery with the capacity of 75 TBPD costs **about 60 per cent of the cost of a new plant** (Rae Campbell, Sharjah Oil Refining).

While the German mineral oil industry is silent about plans for exporting used refineries (see source information for figure 2.16), American companies make no secret about the fact that **more stringent environmental legislation** is a reason for relocating numerous refineries abroad. The US American agency Chemex has the following to say on its website: "*As a result of tougher environmental regulations (...) many North American refineries have ceased operations. Recognizing an opportunity, Chemex redirected its focus to the procurement of quality used refineries*". Chemex has a remarkable track record totalling almost 550 TBPD in capacities already transferred or yet to be transferred. Annex 2.2 shows the origin and destination of the plants.

	Year built	Size (TBPD)	Setting of the works	Price in million US$
1	81	12	87	not known
2	not known	10.4	not known	not known
3	not known	30	84	5.5
4	not known	20	85	2
5	60	17	not known	6.5
6	58	40	not known	19.5
7	not known	45	not known	not known
		174.4		

Figure 2.16: Used refinery capacities of a German dealer

From two agents alone (Chemex and the German dealer behind the offers in figure 2.16) offer or have offered used capacities of 720 thousand barrels per day. This corresponds to about 36 million tonnes a year and is thus on the same scale as the estimates mentioned above. Assuming that there are further suppliers of second-hand refineries and second-hand refineries are transferred to developing countries and emerging markets in the context of foreign investments, it seems conceivable that in the coming years **used refinery capacities of more than 100 tonnes/ annum** will be transferred to developing countries and emerging markets.

The US government is also aware that second-hand machinery and equipment are exported in the field of oil and gas (SIC3533). The Department of Commerce reports that US exports

in this area exceeded “new product shipments” by 1.4 billion US$ in 1996.

2.7.3 The generation of energy

In view of the many different power station processes it is difficult to make precise surveys in this sector. Used conventional **power station capacities of 17.2 GW** can be found on various internet sites specific to certain sectors, above all at those of Foster Power Generation, DEV, CH Non-Food Import-Export and Lohrman. They offer all the usual power station processes, even including two atomic power stations with a capacity of 1.2 and 2.4 GW. The average output of fossil-powered power stations lies at 190 MW. The little information there is about age indicates that the **average age of the power stations is between 25 and 30 years**. Figure 2.17 clearly shows that in Germany there are about 540 fossil-powered power stations with a total output of 34.5 GW which are more than 25 years old. It is possible that they will be on the market for second-hand goods in the next few years or that they are already included in the used power station capacities currently on offer.

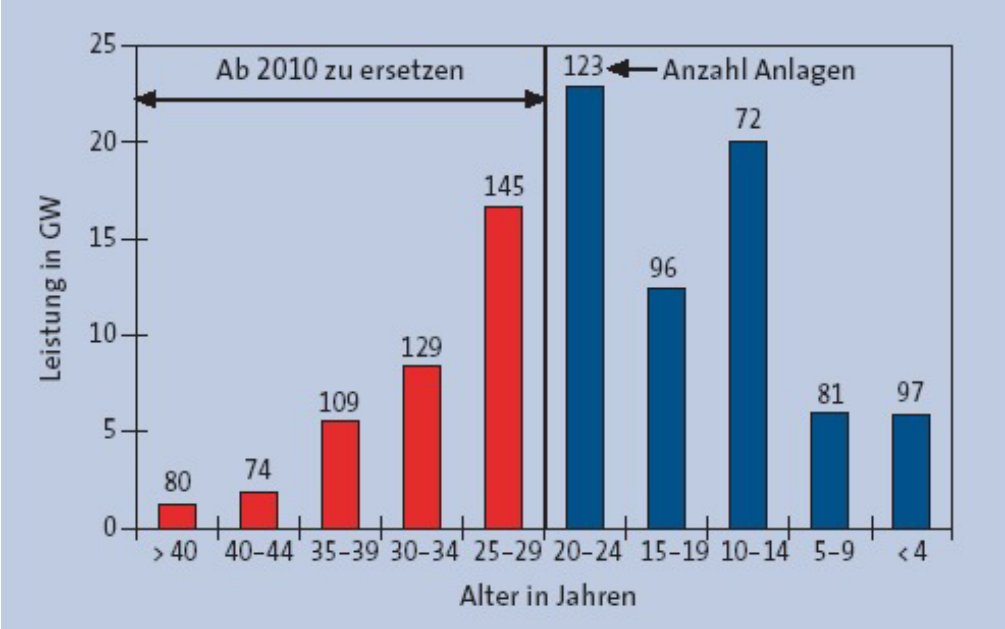


Figure 2.17: **Age structure of German thermal stations among VGB members (x-axis: performance in GW; y-axis: age in years, >25 years have to be replaced as of 2010)**
Source: RAG

In addition to these capacities, which are usually sold as "complete plants", there are also numerous and important **power station components** on offer, such as individual steam or gas turbines. Lohrmann alone, for example, offers about three GW in steam turbines. It is estimated that second-hand turbines and boilers with a capacity of at least a **further 10 GW** are available world-wide. It was not possible to obtain exact data on the origin of the power station capacities from dealers. However the data available for second-hand diesel generators was more precise.

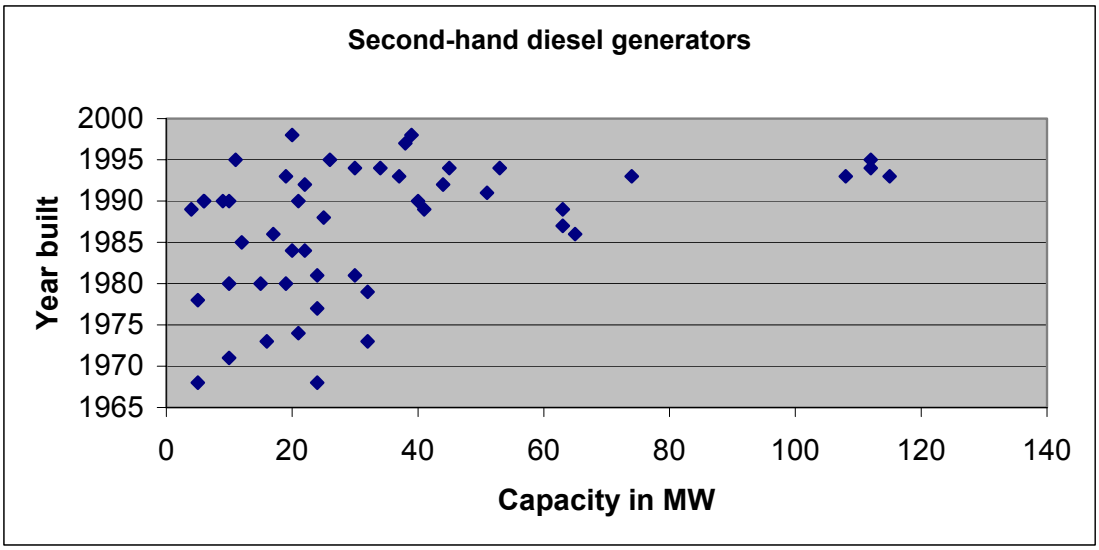


Figure 2.18: The world-wide market for second-hand diesel generators
Source: various internet portals, 2002

The 48 diesel power stations offered by various dealers at internet exchanges have a total output of 1,680 MW. The average size of the individual power stations is thus 35 MW, sometimes spread over two or several individual generators. The age structure shows a trend away from relatively small plants in the 1960s and 1970s to plants with a total capacity in excess of 100 MW. The average age of the plants is eight years. The average costs lie between €100 and € 300 per kW "where is", i.e. without transport. In many developing countries and emerging markets with subsidised diesel prices for industry, diesel power stations represent an interesting alternative for the generation of energy.

It is emphasised again that here only the capacities brokered by dealers with the aid of the internet are mentioned. Transfers by operators that are made directly or in the form of investments in developing countries and emerging markets are not covered here. However they could be on the same scale or even greater.

2.7.4 Steel production

Horst Wiesinger, Vice President of Voest-Alpine-Industrieanlagenbau divides the market for steelworks into two country groups. For developing countries and emerging markets with an average income of less than 10,000 US$ per inhabitant and a steel consumption of below 300 kg per year and person he expects the establishment of new or second-hand plants. In industrialised countries with a predominantly saturated steel market he expects that there will be a need for modernisation and automation with individual components being replaced to only a small degree. By 2010 he reckons with an additional investment potential of **32 million tonnes of steel production capacity world-wide**. Probably about a third will be invested in new plants and two thirds in the modernisation of old plants (Mining Annual Review, October 2001).

As the following case study reveals, even China has granted exceptional approvals for the import of second-hand machinery and equipment in view of the lower costs of investment and their strategic importance. The Canadian Embassy in Peking reports of at least three further transfers of second-hand equipment to China in the recent past. Fourteen further blast furnaces are waiting for buyers in Germany, Belgium, France and Luxembourg (Handelsblatt).

The case study of China

What was probably the biggest industrial dismantling of all times took place in Dortmund, Germany. There, in 2002, a steel works of Thyssenkrupp including, blast furnaces, roll mill and blast roasting plant was dismantled into its individual parts and shipped to Jiangsu in China. The plant, which was built in 1960, has a total capacity of 4.5 million tonnes of steel per year (DER SPIEGEL, 15/2002, "China-Town in Westfalen“). The corporate buyer, Shasteel, is part of a state-owned steel group with a turnover of more than a billion US$. 30 German technicians and 800 Chinese fitters achieved a logistical tour de force in Dortmund. An exacerbating factor was that the plant was built up again at the same time in China in order to save time. While the former costs of investment for Thyssenkrupp amounted to two billion euros, the second-hand value was only 100 million euros. On top of this came 100 millions euros for the transport of a total of 250,000 tonnes of heavy plant components and the costs of disassembly and installation (Asiainfo Services, March 2002). It is planned to put the plant back into operation in the spring of 2004. The press has published many reports about this story (and there has also been a television programme by Deutschlandfunk in Asia). The main emphasis of the reporting was more on logistics and cultural aspects. No mention was made of possible pollution. The capacity of the transferred works corresponds to around **4 per cent of the total capacity in China**.

2.7.5 The cement industry

Every year 1,300 million tonnes of cement are produced world-wide and sold at an average price of 70 US$ per tonne. The industry can be described as being particularly capital-intensive, characterised by high energy costs, low product differentiation and high transport expenses. The main environmental impact includes pollution of the air and the consumption of energy. At present **used capacities totalling eight million tonnes a year are on offer** on various internet platforms (source: Nelsonequipment Canada, Fordberry UK, Hensel Industry). The equipment on offer consists of plants with capacities of between 36, and 2.4 million tonnes a year. It was not possible to discover the exact origin of these capacities and to obtain more detailed technical information. It can be assumed that a much greater amount of second-hand equipment or equipment components are exported to developing countries and emerging markets world-wide in the form of foreign investments in the cement industry.

Importance	Germany	Italy	Spain	UK	Poland
First	Labour costs	Environm. costs	Labour quality	Location	Age of plant
Second	Enforcement of environmental regulation	Age of plant	Location	Age of plant	Size of plant
Third	Environm. costs	Labour costs	Quality of raw material	Size of plant	Manufacturing costs

Figure 2.19: Competitive disadvantages in the cement industry in various countries Source: Wagner K., Triebswetter U., "The Impact of BAT on the competitiveness of the European Cement industry", June 2001

The main motives of German industry in selling a cement plant second-hand or in relocating a plant are the **high wage costs and the tough environmental legislation**. But as the age of the plants can also be a competitive disadvantage, it must be assumed that it usually tends to be very old plants that are replaced. The graduated effects in the cement industry also play an important role. Annex 2.3 shows the transformation from small plants to large ones and the decline in the number of plants in Germany, i.e. the freeing of used capacities.

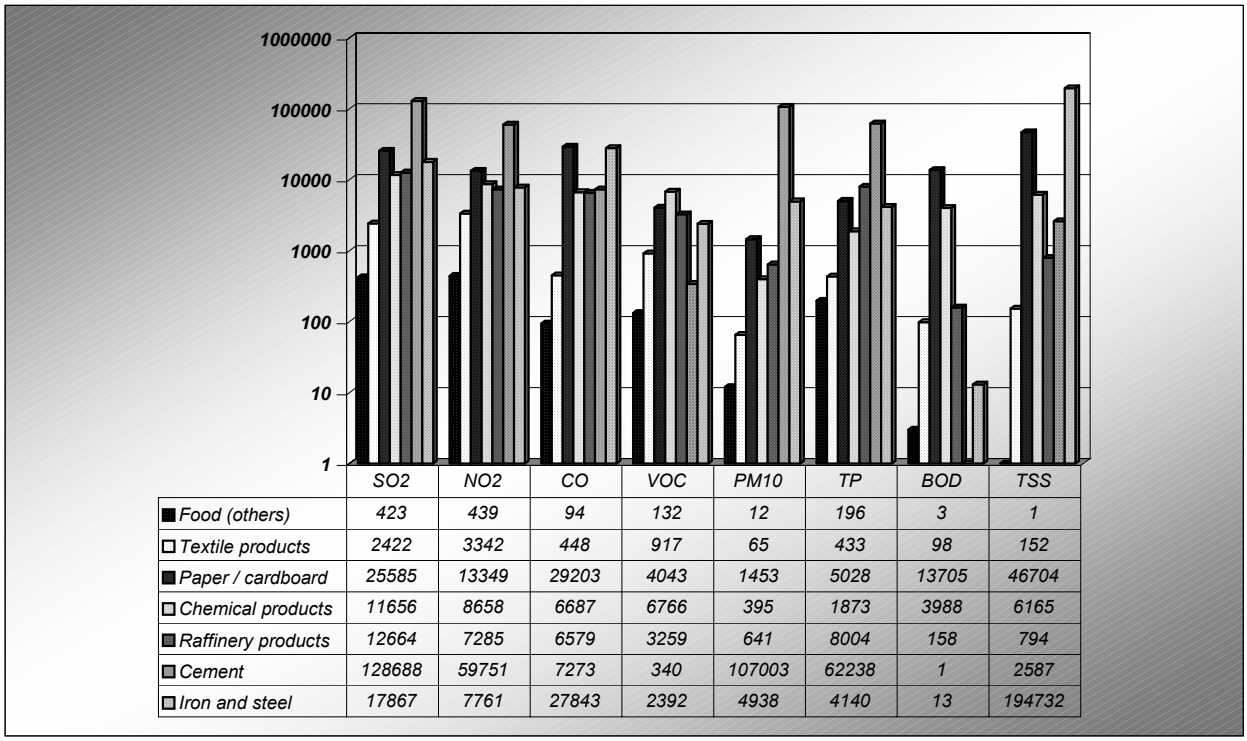
On the buyer side the same competitive factors play a role, but on a different level and with a different weighting. The Polish cement industry plays a particular role due to its geographical proximity to Germany and the resulting high proportion of exports. Cement exports from Eastern Europe to Germany have risen dramatically since 1990. In 1996 exports from Poland, the Czech Republic and Slovakia together totalled 4.7 million tonnes (Association of German Cement producers, BDZ). It can be assumed that Polish industry is currently using largely outdated technology. Within the context of its accession to the EU Poland is probably making efforts to modernise and enlarge its plants, either using its own resources or with the assistance of foreign enterprises. Second-hand machinery and equipment could also be used here. Second-hand plants from Europe which no longer satisfy the new requirements in Poland should probably find a market in Poland's neighbours to the east.

2.8 An estimation of the impact

2.8.1 General considerations

In view of the relative inhomogeneous and "mosaic-like" database, estimations of the environmental impact of second-hand goods are characterised by a high degree of imprecision. In order to nevertheless obtain an initial impression of the scale of the polluting effects of the export of second-hand goods individual data packages will be used below as a basis for rough **macro estimations**.

Typical emissions in various, particularly polluting industrial sectors depending on the production figure are shown in figure 2.20. The specified values relate to the production basis of the USA in 1987.



	SO2	NO2	CO	VOC	PM10	TP	BOD	TSS
Food (others)	423	439	94	132	12	196	3	1
Textile products	2422	3342	448	917	65	433	98	152
Paper / cardboard	25585	13349	29203	4043	1453	5028	13705	46704
Chemical products	11656	8658	6687	6766	395	1873	3988	6165
Raffinery products	12664	7285	6579	3259	641	8004	158	794
Cement	128688	59751	7273	340	107003	62238	1	2587
Iron and steel	17867	7761	27843	2392	4938	4140	13	194732

Figure 2.20: Typical emissions in various industrial sectors depending on the production figure (in pounds/US$ 1987)
Source: Wheeler, „IPPS – The Industrial Pollution Projection System“

Figure 2.20, together with figure 2.5, provides an initial rough estimation of the emissions in connection with the transfer. The fact that the statistics are relatively old is more of an advantage in this case as the specified figures tend more to correspond to the emissions from used capacities. A more in-depth evaluation of figure 2.5 does not seem to make much sense here as there is insufficient information on the costs of machinery and capacities per sector.

A quantitative approach is a macro estimation based on the quality of the second-hand machinery and equipment on offer. If we take the **age structure** of the second-hand machinery from figure 2.8, it is possible to assess the additional consumption of energy in comparison with that of new machinery. **Increases in energy efficiency** of one per cent per year thus result in the additional consumption of energy shown in figure 2.21.

	Additional consumption of energy due to the use of second-hand machinery and equipment (Increase in energy efficiency of 1% / year)
Food	23%
Chemicals	22%
Machine tools	17%
Diesel generators	19%

Figure 2.21: Additional consumption of second-hand machinery and equipment through increasing the energy efficiency of various sectors

On this basis it could therefore be said that the **capital stock sold second-hand every year with a value of about 100 billion US$ consumes an average of 20 per cent more energy** than what is possible with the most modern machinery.

2.8.2 The processing of mineral oil

The mineral oil industry is the biggest consumer of energy in the manufacturing industry. A large part of the energy comes from the refinery process itself. In comparison with the predominant technologies, especially in developing countries and emerging markets, modern technologies can reduce the energy consumption of some important processes by up to 60 per cent (ETI – Climate Change Report). In "The oil and gas industry – from Rio to Johannesburg“ the International Petroleum Industry Environmental Conservation Association reports some pronounced improvements. Thus European refineries have

- reduced their waste water by 97 per cent since 1970,
- reduced emissions of SO_2 by 40 per cent since 1980,
- improved energy intensity by 8 per cent between 1992 and 1998 and
- increased the rate of recycling from 26 to 62 per cent since 1985.

Natural oil refineries emit a large amount of SO_2 and VOC and lesser amounts of dust, NO_x and CO. In view of the large number of process steps and the high number of possible products it is difficult to define emission factors. However Corinair estimates the VOC emissions of modern, Western-European refineries at 0.225 kg per tonne of input. On the other hand refineries of older design - and these are probably up for sale as second-hand refineries - have emissions of 0.9 kg per tonne of input. Furthermore Corinair estimates that in 1990 the VOC emission factors in Poland were 2.2 times as high as corresponding readings in Germany, six times as high in Lithuania and as much as 30 times as high in the former USSR.

Used refinery capacities of 100 million tonnes a year would thus lead to **VOC emissions of 90,000 tonnes a year**, 67,500 tonnes more than the comparable capacity of modern European refineries, depending on the country of destination, but considerably less than the existing production basis.

An investigation of 29 Canadian refineries has revealed that the following emission factors can be assumed for refineries in industrialised countries, on an initial approximation (in kg/m^3 of input): SO_x – 0.8; NO_x – 0.05 and CO – 0.08 (CPPI and Environment Canada). The

specified values roughly correspond to the state of the art of 1990. Thus capacities of 100 million tonnes per year would emit roughly **90,000 tonnes of SO_2, 5,600 tonnes of NO_x and 9,000 tonnes of CO** (basis: 1 m^3 corresponds to 0.88 tonnes of crude oil).

There are already examples which show that the export of second-hand refineries to developing countries and emerging markets has caused substantial **pollution of the environment**. Thus a former US American refinery that was transferred to Cubatao in Brazil is now among the biggest polluters in the country. In the 1970s and the 1980s Brazil tried to maintain its rapid economic growth by means of such imports, among other measures (Journal of Commerce).

2.8.3 Power generation

Figure 2.22 shows the development of the specific emissions of coal-fired power stations in Germany which - in terms of quality - also apply to other fossil-powered power stations in Germany. Emissions of SO_2, NO_x and dust were drastically reduced through the use of suitable primary and secondary reduction measures, particularly between 1980 and 1990. Emissions of CO_2, which are largely connected with the effectiveness of a power station, have fell by roughly 12 per cent between 1990 and 2000. In the case of coal, emissions of CO_2 in relation to fuel lie between 750 and 970 kg/MWh, between 640 and 820 kg/MWh in the case of heating oil and between 450 and 580 kg/MWh in the case of natural gas (RAG). The higher figure is probably valid for older power stations that will be replaced in the next few years and which may then be sold second-hand.

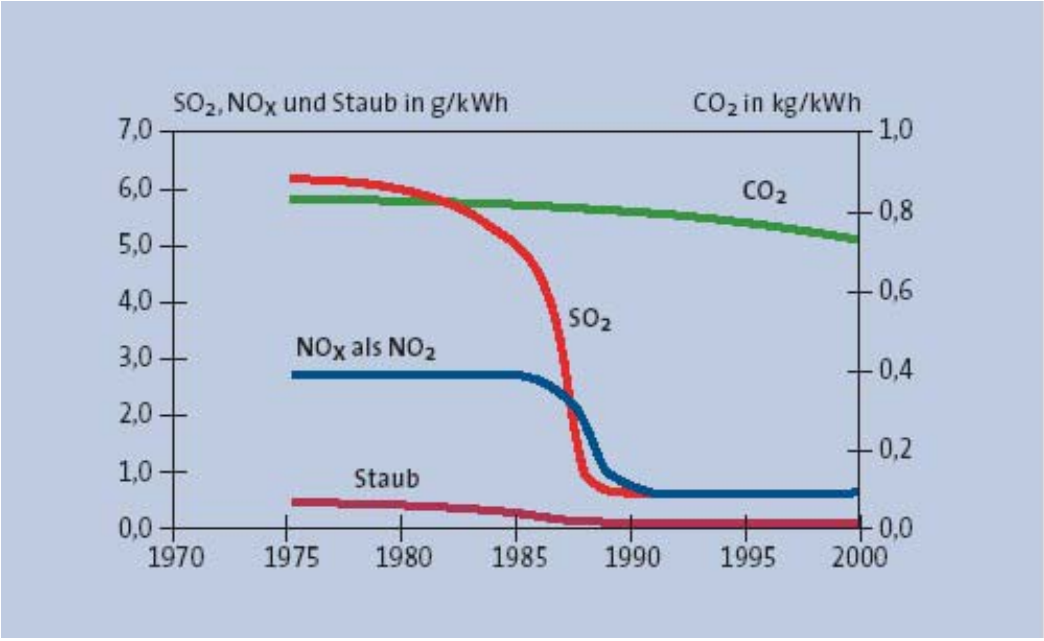


Figure 2.22: The chronological development of specific emissions of German coal-fired power stations (Staub = particles)
Source: RAG

The environmental impact of selling second-hand fossil power station capacities will now be estimated taking the example of a transfer to India and Brazil. Various types of power station

zones will be compared with different types of fuel (see OECD - An Initial View on Methodologies for Emission Baselines, see also Annex 2.4).

Type of power station	India	Brazil
Existing fossil power station zone	1117	892
Newly built fossil power station zone	960[5]	807
Newly built power stations running on oil l[6]	661	761
Newly built power stations running on coal[6]	1085	953
Newly built power stations running on gas[6]	418	426
Option 1: BAT gas[1]	382	
Option 2: BAT coal[1]	786	
Option 3: BAT fossil[4]	590	
Option 3: gas second-hand[2]	580	
Option 4: coal second-hand[2]	970	
Option 5: oil second-hand[2]	820	
Fossil second-hand[3]	790	

Figure 2.23: CO_2 emission factors of various types of power stations in India and Brazil and of various options (in kgCO_2/MWh)

1 - see OECD study, 2 - basis: older German plants, 3 - basis one third oil, one third gas, one third coal of older German plants, 4 – estimated, 5 - The power station zone in India, newly built since 1994 or still under construction consists of 617 power stations with a total output of 36 GW, 6 – see OECD study; unclear whether some of the power stations in use might even be second-hand.

A number of assessment variants can be developed with this basic data:

Solution 1	Instead of solution 2	India (in %)	India (absolute)**	Brazil (in %)	Brazil (absolute)
Fossil, second-hand	Exist. fossil zone	-29%*	-65	-12%	-20
Fossil, second-hand	Fossil new	-18%	-34	-2%	-3
Fossil, second-hand	BAT fossil	+34%	+40	+34%	+40
Fossil, new	Exist. fossil zone	-14%	-31	-10%	-17
Coal, second-hand	Newly built, coal	-11%	-23	+2%	+3
Oil, second-hand	Newly built, oil	+24%	+32	+7%	+12
BAT, gas	Exist. fossil zone	-66%	-147	-58%	-102
BAT, fossil	Exist. fossil zone	-48%	-105	-33%	-60
Fossil, second-hand	Newly built, gas	+89%	+74	+85%	+73

Figure 2.24: The effects of various assessment variants on the emission of CO_2

* Improvement through solution 1 as opposed to solution 2 - ** absolute change in relation to a transferred capacity of 23.6 GW in million tonnes of CO2 emissions

In relation to the output of 23,6 GW from second-hand power station capacities **actually offered world-wide** (200 TWh of electricity per year at a utilisation factor of 0.75), the following results would be obtained, for example:

1. **a reduction of 147 million tonnes in CO_2 emissions per year** if BAT gas were to be used in India instead of the existing fossil power station zone (in theory the most ecological of all solutions);

2. an increase of 40 million tonnes of CO_2 per year if fossil second-hand power stations were to be used instead of fossil BAT - no matter where (more pollution of the environment through the use of second-hand power stations that has to be weighed up against the additional costs for BAT);

3. an increase of **73 million tonnes in CO_2** emissions per year if fossil second-hand power stations were to be used instead of the usual newly built gas power stations in Brazil (realistic, but gives cause for concern, as the investment decision falls in favour of a more polluting energy carrier);

4. a reduction of 23 million tonnes of CO_2 per year if second-hand coal power stations were to be used in India instead of the coal power stations usually built at present and a slight increase if this were the case in Brazil.

The export of second-hand power stations to countries with high emission figures tends to be more acceptable than a transfer to countries with low emissions (Annex 2.5). It is therefore also interesting to also take a look at the emissions caused by energy in the specific countries, reflecting the age and the composition of the power station zone.

It is only possible to make very limited statements about other harmful substances that are produced through the generation of energy as they mainly depend on whether the corresponding measures to reduce the harmful substances (such as flue gas desulfurising plants) are also exported. However this is improbable as

- most of them are still relatively new and it may be possible for them still to be used in the country of origin;
- the costs for the buyer would increase without there necessarily being any demand;
- very many individual components are sold anyway (e.g. steam turbines);
- some components are old, but still unused and are not therefore upgraded.

If second-hand coal power stations were transferred without desulfurisation measures, emissions of SO_2 would be about 5g/kWh higher, as is shown in figure 2.22 . At 23.6 GW (200 TWh) this would roughly correspond to one **million tonnes of SO_2 per year**.

2.8.4 The steel industry

The steel industry is usually the biggest industrial consumer of coal and electricity and also one of the biggest emitters of CO_2.

The estimation of the environmental impact of the transfer of second-hand steelworks will be made taking the **example of China**. The energy intensity of Chinese steelworks is far in excess of the international standard (see Annex 2.6). However in the course of the last 20 years it has considerably improved and has fallen from 1.56 toe/tonne in 1980 to 0.94 toe/tonne in 1996. The comparative figure for Germany is currently 0.34 toe/tonne (GEMIS 4.1). The transfer of second-hand steelworks to China should therefore reduce the average figure even further.

The energy intensity of the steelworks actually transferred from Germany to China (see case study on China) is not known. The works were built in the 1960s and put out of operation at the end of the 80s. It can therefore probably be assumed that it had the technological state of the art of 1980. If the development of the energy intensity of US American steelworks shown in figure 2.25 is taken as a basis, the works could have had an energy intensity which is 70 per cent higher than that of the average works in Germany at present (i.e. 0.57 toe/tonne). The transfer of the capacity of **4.5 millions tonnes of steel** per year thus results in an energy consumption of **2.56 million toe per year**. This means one million toe more than the transfer of an average works from Germany, but also 1.7 million toe less than Chinese works of this capacity consume on average. In relation to the emission of CO_2 **7.65 million tonnes of CO_2 per year are emitted** due to the transfer.

If it is assumed that half of the approx. 6 per cent growth in the capacities of Chinese steel production is achieved through plants of this sort (i.e. roughly an additional 3 million tonnes per year), this would mean that **280 million tonnes of CO_2** would have been emitted after 10 years. This means 115 million tonnes more than is emitted by comparable works in Germany.

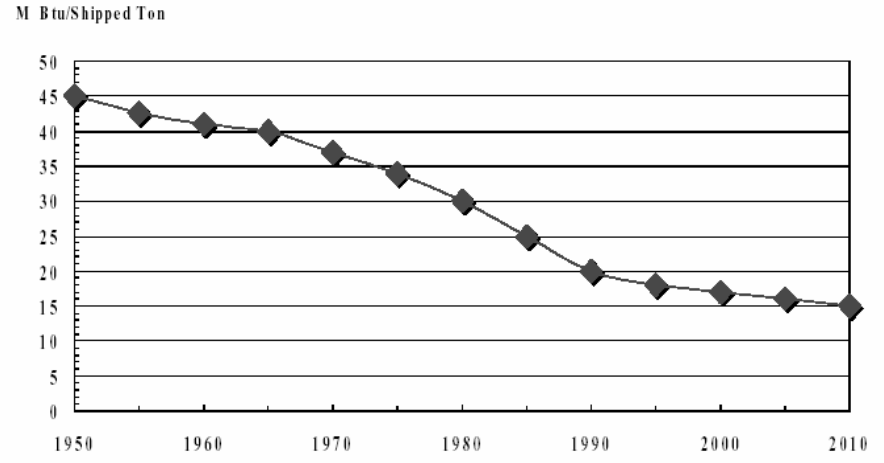


Figure 2.25: The development of the energy intensity of US American steelworks
Source: Stubbles, 2000

2.8.5 The cement industry

As was shown in chapter 2.7.5, second-hand **cement works** are currently being offered with a total capacity of at least eight million tonnes. As neither the exact volume nor the origin and destination of the second-hand exports are known, it is only possible to make **very simplified qualitative estimations** of the environmental impact. This will be done on the basis of a theoretical transfer from Germany to Poland.

The quality of German plants is very high on a European comparison, as is evident from figure 2.26. However it can be expected that capacities that can be called "poor performers" will be reduced, mainly due to tougher environmental legislation. These are plants which only meet one BAT criterion or none at all. They usually have emissions of NO_x in excess of 800 mg/m^3 and higher, i.e. the export of such a plant would involve an additional **300 mg/m^3 in comparison with BAT**.

Countries	BAT	Middle	Poor	All plants
Germany	2	5	1	8
Italy		6	1	7
Spain		1	4	5
UK	1		4	5
Poland		1	3	4
Total	3	13	13	29

Figure 2.26: Number of the cement works according to environmental classification and country*) **)
Source: Hitchens

*) BAT emission level: NO_x - 200 - 500 mg/m^3, SO_2 - 200 - 400 mg/m^3, dust - 20 - 30 mg/m^3,
**) 16% of all cement works in the countries in question were investigated.

However the quality of existing Polish plants is so poor that a second-hand German cement plant in Poland would probably have emission readings that are so good that they are better than average. A similar picture reveals itself as far as the consumption of energy is concerned. Here **Poland's technological time lag** in the cement industry **in terms of cyclical development** becomes particularly evident. The consumption of energy of German cement works fell from 107 to 102 kWh/t between 1990 and 1999. In roughly the same period these readings fell from 122 to 108 kWh/t in Poland. If a second-hand German cement plant with a state of the art of 1990 were to replace a cement plant of the same age in Poland, this would mean a "saving" of 15 kWh/t. However **5 kWh/t more would be consumed** than if modern plants had been exported.

If we take these margins for the transfer of the capacities of eight million tonnes actually for sale, this would mean potential savings for the buyer of 120 million kWh per year in comparison with existing technology. It would also mean an additional burden of 40 million kWh per year in comparison with modern German technology. These readings could be

considerably higher if there were to be a change of technology from the "wet process“ to the "dry process“ or if exports go to recipient countries such as India where the average energy efficiency is still considerably below the figures for Poland.

It should be noted that the factories in Eastern Europe that have now been taken over by western European groups (including Heidelberger and Lafarge) are coming close to the local environmental guidelines through the use of highly efficient filter systems. Until 1998 cement factories in **Romania**, for example, produced as much as 1,000 mg/Nmc of dust. In 2002 most of them were at the permissible limit of 50 mg/Nmc. Since 1998 cement producers in the country have invested a total of € 50 million in modernisation, a large part of this going into measures for the protection of the environment (bfai).

3 The transfer of second-hand vehicles

If it is considered that there are approx. **700 million cars** throughout the world it can be imagined that the concomitant pollution represents a serious threat to the environment and to health. Technological progress and stricter environmental legislation in industrialised countries have resulted in a considerable reduction in the emission of harmful substances per vehicle. However the rapidly growing vehicle fleet and at the same time the lack of financial resources in developing countries and emerging markets are creating **increasing environmental problems**. While only one fifth of all kilometres driven were in developing countries in 1990, it is predicted that by 2030 this will already be half (IIEC, "opportunity knocks“). A particular problem in this connection is the **age of some vehicles** and the disproportionately high emission of harmful substances that this involves. Thus in Mexico, for example, around 60 per cent of all kilometres driven can be attributed to cars that are more than 10 years. These are responsible for 90 per cent of all hydrocarbons and carbon monoxides emitted and for 80 per cent of all nitrogen oxides.

A number of strategies have crystallised with which it is attempted internationally to master the problems associated with old vehicles. Above all these include increased inspection and servicing, upgrading, premature scrapping, the use of alternative fuels and import restrictions. The latter play a particular role in connection with second-hand vehicles and will therefore be first looked at separately.

3.1 The general legal conditions

Throughout the world the three following legal approaches have successfully contributed towards keeping the adverse effects of the import of second-hand vehicles within limits (OECD, 1999):

- a ban on the import of certain types of second-hand vehicles or machinery;
- high taxes or customs duties for imported vehicles or machinery;
- strict emission tests as a precondition for registration.

Pelletiere has made a statistical investigation of import policies regarding second-hand vehicles and comes to the following conclusion:

61 out of 111 countries restrict the import of second-hand vehicles, of which

- 21 impose an absolute ban on imports,
- 23 impose a ban on imports that are more than five years old and/or heavy customs duties and
- 17 impose a ban on imports that are more than six years old and/or low customs duties.

47 of the 111 countries have introduced emission standards. 31 of these 47 countries are either industrialised or countries of Central and Eastern Europe which desire accession to the European Union. This means that only 16 of the 70 developing countries and emerging markets remaining have emission standards that are worth mentioning.

Bulgaria is the only country in Eastern Europe which does not impose any age limits for the import of second-hand vehicles. Consequently in recent years all vehicles that did not find any buyers even in the other Central and Eastern European countries have been transferred to Bulgaria. Due to a totally outdated vehicle fleet (on average more than 20 years old) a unique concentration of job-creating repair garages has developed, interestingly enough. The reason for this unique policy is obviously the strong lobby of importers who import between 80,000 and 90,000 cars each year, some of which are no longer roadworthy.

A frequent practice seems to be that vehicles are declared as being "for re-export" and then nevertheless remain in the country. Customs regulations and customs duties can therefore sometimes be circumvented. In this way, for example almost 100,000 cars found their way to the **Ukraine in 1999**. New regulations on customs and different customs rates have promoted the limitation of the "non-official import", particularly that of second-hand cars. As a result, the import of second-hand cars is said to have almost halved in comparison with 2000 (bfai).

There have obviously been some inconsistencies in **Russia**, where only recently new guidelines for customs have meant that "grey imports" which were once quite substantial, have more or less ground to a complete halt. The Russian government is obviously planning to introduce higher import customs as a restriction on the import of second-hand cars and at the same time to protect its own industry. However in the middle of January 2002 a decision was already postponed yet again (bfai).

The effectiveness of tougher import regulations becomes apparent if we look at **the Czech Republic**. Even the announcement of stricter regulations caused imports to soar to record levels in 1999. In the Czech Republic second-hand vehicles which were first registered before 1 July 2001 need to meet the Euro 2 standard. At the beginning of 2002 the Czech Republic allowed the import of vehicles up to an age limit of eight years. At the same time the imported cars must meet at least the Euro 2 standard. According to the Czech News Agency (CTK), the new legislation has given rise to controversial discussions in the country as negative environmental effects are too feared.

Poland has also introduced age limits for second-hand vehicles. Apart from this, catalytic converters are obligatory. Second-hand trucks may be no more than three years old. **Romanian** authorities are introducing the Euro emissions standards in stages. Thus since 1 January 2002 no second-hand vehicles which do not meet the Euro 3 standard may be imported while domestic car manufacturers are obliged to equip their cars with catalytic converters (bfai).

Since 2000 Hungary has been pursuing a policy of liberalisation as regards the import of second-hand vehicles. This is due to the harmonisation of legislation with the corresponding EU standards. While administrative restrictions have been annulled, the imports are subjected to strict functional checks. The result of this policy is comparatively low numbers of units imported at a relatively high average price.

Country	
Brazil	Import ban on second-hand vehicles, import of vehicle parts only with special permit
Bulgaria	No age limits
China	Import not possible
India	No more than three years old, restrictions on quantity annulled, licences no longer needed, more tariff and non-tariff trade barriers, .e.g. customs rate of 105%.
Mexico	Import not permitted, exception; areas bordering the USA.
Poland	Age limits for second-hand vehicles
Russia	Permitted, restrictions planned
the Czech Republic	Maximum age raised to eight years. exhaust gas standards
the Ukraine	Maximum age of eight years since 2000 (formerly five years), 100,000 grey imports (declared as transit goods)
Hungary	Liberalisation for second-hand imports, stricter functional checks
Africa	Age limits of between five and ten years, some limits for harmful substances, poor implementation of the import regulations

Figure 3.1: Summary of the legal conditions in various developing countries and emerging markets

The legal conditions for the import of second-hand vehicles to **Africa** are very diverse. However it appears that most African countries have introduced an age limit for second-hand cars of five, eight or, more frequently, ten years. Some countries even have fixed limits for harmful substances. The enforcement of the laws, however, seems very arbitrary. Thus "Agence France Press“ reported in August 2002 that several thousand second-hand vehicles in the port of Lagos, Nigeria, were suddenly refused an import permit as some of them had exceeded the statutory age limit of five years. It is questionable whether this blockade actually will reduce polluting imports or whether the market for second-hand vehicles will once again find loopholes.

It is important to remember that the legal conditions described merely represent a „snapshot" which can change at any time. It remains to be seen how particularly countries such as China, Brazil, India and Mexico will position themselves vis-à-vis the **WTO regulations** and what influence environmental aspects will have on the decisions taken. At present the import regulations in these countries are very restrictive.

Brazil and **China** have imposed a general import ban on second-hand vehicles. Second-hand spare parts may only be imported with special approval. **Mexico** currently permits the import of second-hand vehicles to some border regions. There imported cars are permitted up to an age of 15 years. From 2009 there will be a step by step relaxation of the rules concerning the import of second-hand vehicles from the NAFTA area. All restrictions will have been abolished by 2019. Similar regulations are planned for imports from the EU. It is remarkable that in Mexico there are several tens of thousands of second-hand cars on the road that are still registered in the USA. In **India** there are a large number of **tariff and non-tariff barriers** which make import virtually impossible. Imported second-hand vehicles, for example, must have a right-hand drive and measure speed in kilometres. The importer must certify that the car has a roadworthiness of at least another five years and must guarantee a supply of spare parts during this time. In addition the importer must provide several pre and post shipping certificates. Second-hand cars may only be imported through the port of

Bombay. The restrictive import policies of the countries mentioned is mainly intended to **protect indigenous industry from competition**. In the meantime India itself is interested in exporting second-hand vehicles to neighbouring countries such as Bangladesh. The Indian government has requested the market leader, "MARUTI", to work out a concrete proposal presenting the legal details of such a trade (Financial Times, Business Line, 2002).

International **automobile groups** are increasingly entering the debate concerning the import of second-hand vehicles. "Volvo India" claims that the technical fittings of the imports are not suitable to local conditions (India Business Insight, August 2000). "Ford India Ltd." has decided against importing second-hand cars which are currently selling in Europe and the USA. Thus Ford dealers are not permitted to ship second-hand cars to India. The company considers the import of second-hand cars to be dubious as neither safety standards, emissions nor the supply of spare parts has been taken into account. As a countermove the company places its hopes in its own production strategy. More likely reason in the case of both companies is fear of the competition.

It is noticeable that there do not seem to be any restrictions world-wide to restrain the **export of second-hand vehicles**. It is therefore up to the importing countries whether the economic, social and ecological advantages of second-hand vehicles or the disadvantages prevail.

A summary overview of the reasons for the export of second-hand vehicles and the motivation of the parties involved can be found in chapter 5.1.

3.2 Estimation of the size of the market

3.2.1 Germany

Type of engine / fuel and cubic capacity		Number exported	Volume in € 1,000**	Average price in euros**
Petrol	<1000	4,766	14,000	3,000
Petrol	1000-1500	47,118	108,000	2,300
Petrol	1500-3000	338,094	1,700,000	5,000
Petrol	>3000	22,316	632,000	28,000
Diesel	<1500	1,629	5,400	3,300
Diesel	1500-2500	96,940	706,000	7,300
Diesel	>2500	10,518	186,000	17,700
Total*		521,381	3.25 billion euros	6,400
Per year		**695,000**	**4.35 billion euros**	**6,400**

Figure 3.2: Exports of second-hand German cars according to type of fuel and engine-capacity class
Source: Federal Statistical Office, September 2001

* January to September, ** figures rounded

According to official export statistics, Germany exported roughly 700,000 second-hand cars with a total value of € 4.35 billion in 2001. As in previous years the main sales regions were **Eastern Europe, Africa and the Middle East**. Poland and Lithuania head the list among the individual countries of acceptance. Thus in the first nine months of 2001 45,000 cars were sold to Poland alone, for example, in the "petrol / cubic capacity of 1500 to 3000 ccm" segment. The 20 most important countries of import for second-hand German cars already account for more than 80 per cent of all cars sold in by far the most important market segment - as in all the others.

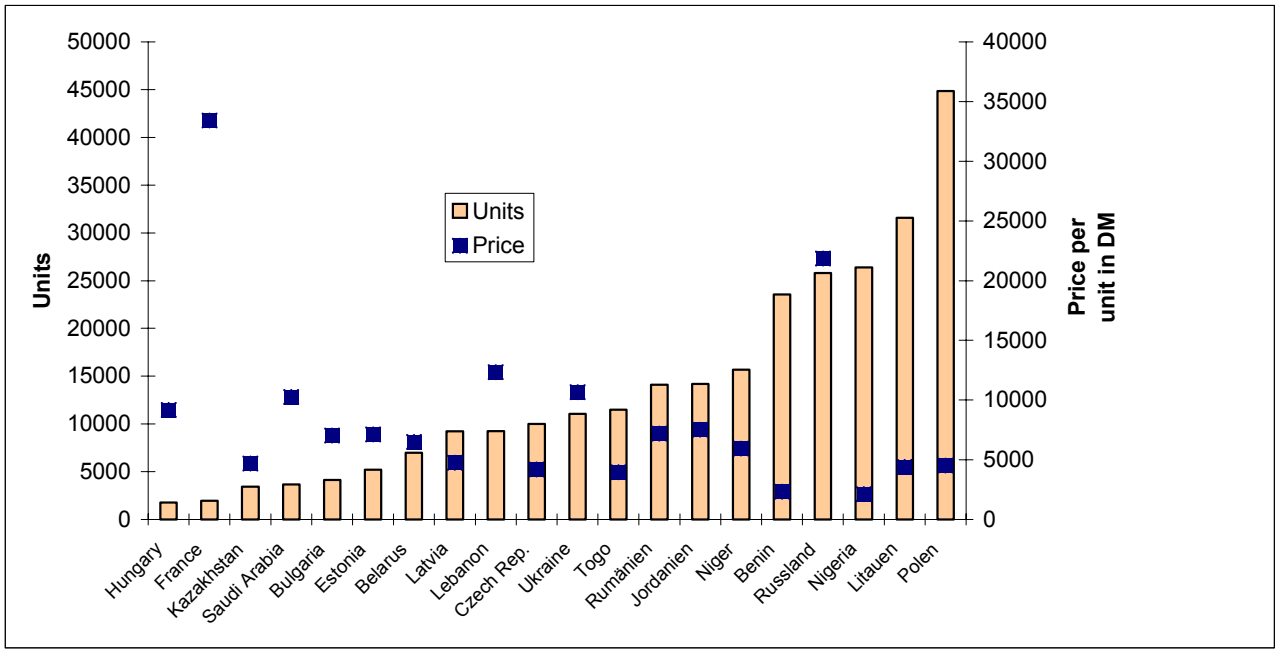


Figure 3.3. **Units and prices for second-hand German car exports with a petrol engine and a cubic capacity of between 1,500 and 3,000 ccm according to countries of destination, January - September 2001**
Source: Federal Statistical Office

A similar picture reveals itself as regards the second most important market segment: cars with a diesel engine and a cubic capacity of between 1,500 and 2,500 ccm.

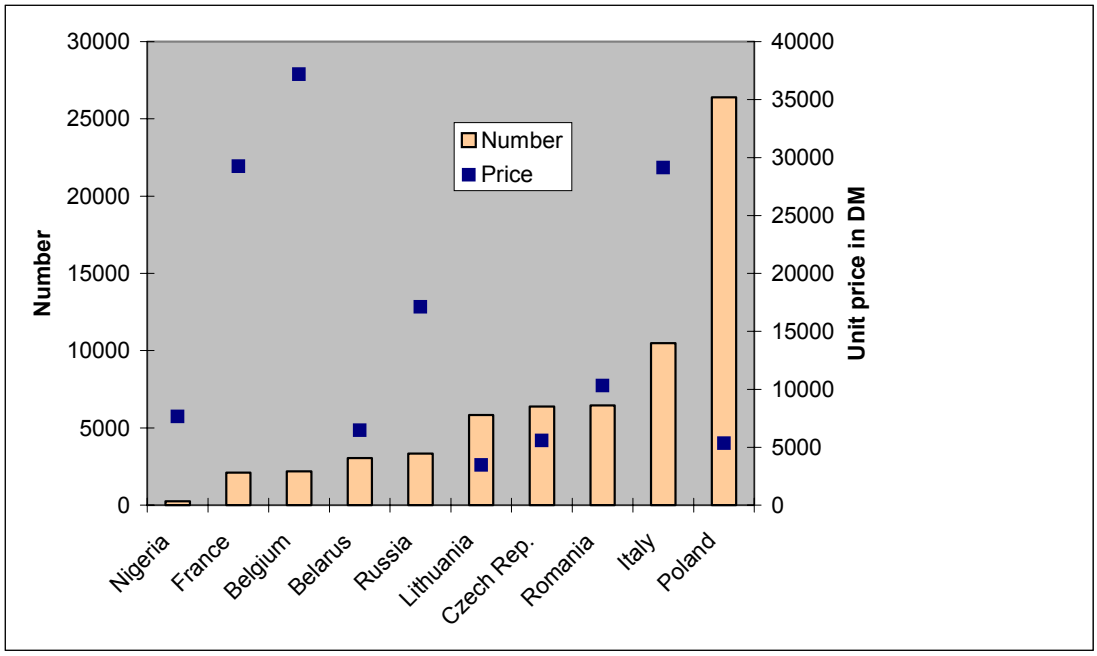


Figure 3.4: **Units and prices for second-hand German car exports with a diesel engine and a cubic capacity of between 1,500 and 2,500 ccm according to country of destination, January-September 2001**
Source: Federal Statistical Office

An interesting picture and an initial indication of the **quality of the cars sold** reveals itself if we look at the **average unit price** of the cars sold per country. There are some considerable differences here. While the average selling price of all cars lies at around € 5,000, the average price per importing country fluctuates between approx. € 16,500 (France) and € 1,000 Euro (Nigeria). The high figure for France is probably due to the relatively high cost of company staff cars. It becomes clear that African customers for second-hand cars pay the lowest prices for their goods. It is also evident that the import prices in Central and Eastern Europe tend to vary a great deal. The import prices for Russia (more than € 10,000) and the Ukraine (more than € 5,000) are surprising at first and lead to the conclusion that cars imported into these countries often tend to be the **more luxurious vehicles** and/or more expensive marques within the market segment. This theory is supported by the fact that in the "petrol >3,000 ccm“ segment Russia is clearly the biggest importer of German second-hand cars. While most Central and Eastern European countries import second-hand cars to the value of € 2,000 to 2,500 for the mid-range sector, it is mainly luxury models that go to Russia and sometimes to the Ukraine as well.

The import laws and limits for harmful substances are clearly reflected in the data. Thus Hungary imports a relatively small number of cars which, at an average price of € 4,500, is only just under the general average. Countries of the Middle East lie between € 3,750 and € 6,250 in this market segment, which suggests a generally better quality of vehicle. Developing countries and emerging markets in Asia and Latin America import almost no second-hand cars from Germany. The situation in the case of **commercial vehicles** is somewhat different, as figure 3.5 shows.

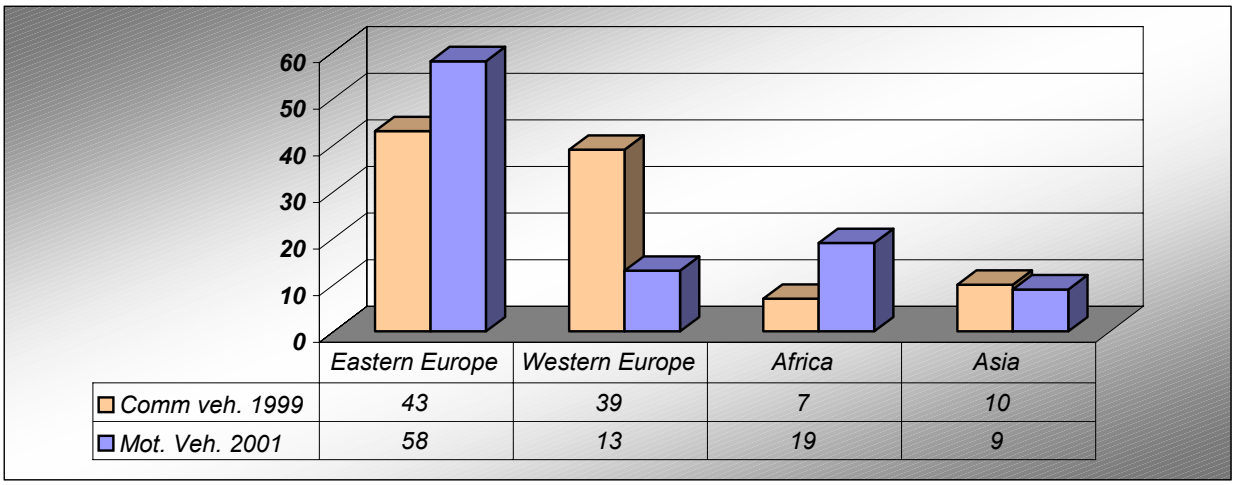


Figure 3.5: **Regions of destination for second-hand German vehicles**
Source: VDA

A look at the **development of German car exports** in recent years shows that the export of second-hand vehicles has risen almost abruptly (figure 3.6). No indication could be found that this increase has anything to do with the introduction of the Old Car Regulations.

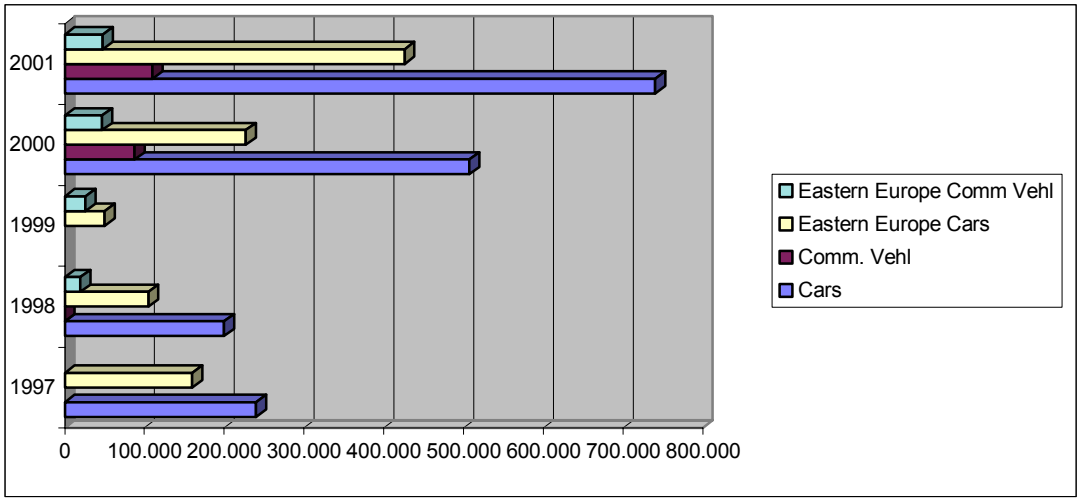


Figure 3.6: **The development of exports of second-hand commercial vehicles and cars in Germany**
Source: VDA

In order to be able to better assess the scale of exports of second-hand goods, it might be appropriate to take a look at the number of motor vehicles in Germany at the end of 2000. For cars the figure was approx. 43,770,000 and for commercial vehicles approx. 3,533,000 (VDA). Thus around **2 per cent of the stock of cars are exported second-hand each year.** Each year second-hand, exported cars account for 20 per cent of new registrations and cars taken off the road, which in both cases lay at around 3,350,000 cars in Germany in 2000 and also in 2001. If it is considered that each year in Germany about 1,200,000 vehicles

(source: ACEA) are disposed of as stipulated by the **Old Car Regulations** (**Altautoverordnung)** it seems likely that a certain percentage of second-hand cars were also exported with the aim of scrapping them more cheaply.

3.2.2 World-wide

An international comparison of the exports of second-hand vehicles makes it clear that each exporting country usually has its **own sales markets** which are relatively close in geographical terms.

	Export of second-hand cars	Export of new cars	Main target markets for second-hand cars
USA (1999)	127,000	235,000	Mexico, Central America, Southern Europe
Japan (1998)	420,000	4 million	New Zealand, South-East Asia, China, Jamaica, Peru, Sri Lanka, Cyprus, Russia, Iraq, Pakistan, Ireland
Korea (1998)	90,000	1.2 million	Russia, South America, South-East Asia
Germany (1998)	200,000	3.6 million	Eastern Europe (Poland, the Baltic, Russia), Western Europe, Africa

Figure 3.7: Exports of second-hand and new cars world-wide - target markets for second-hand exports
Source: D. Pelletiere – George Mason University (USA), Korea Times (Korea), Automotive Environment Analyst (Japan), VDA (Germany)

Taking account of international rates of increase similar to those in Germany between 1998 or 1999 and 2001 (which, however, probably represents the upper limit) more than **three million second-hand cars** a year could be exported world-wide (see figure 3.7).

Japan is the most important exporter next to Germany. In addition to the markets in geographical proximity **Japan** mainly supplies countries with right-drive. In Japan the extremely strict vehicle test, “shaken“, is one of the main reasons for the export of second-hand vehicles. Very many vehicle owners in Japan decide in favour of selling after five or seven years, the time when the second or the third obligatory test is due. In Japan the remaining value of an older vehicle is almost zero. The disposal costs in Japan amount to 20 to 30,000 yen (roughly € 200 at current exchange rates). A cause for concern is the fact that vehicle owners who are planning on selling often neglect to service their cars for years. The export of old vehicles is desirable from an economic point of view as it avoids final storage capacities and the possible pollution that goes hand in hand with scrapping and final storage. In addition to this, the “oriental desire for new goods” may be a further reason for the export of second-hand vehicles. This wish is also reflected in the frequent change of model among Japanese automobile manufacturers. From Japan it is reported that the quality of the second-hand vehicles sold gives cause for concern. The export of vehicles with manipulated odometers seems to be the order of the day. Japanese customs officials believe that the theft of vehicles generally has something to do with the liberalisation of the export of second-hand vehicles (The Daily Yomiuri, Tokyo, November 2000).

The **USA** exports its second-hand vehicles primarily to Central and South America. Within

the framework of a **large-scale study** the United States Environmental Protection Agency (EPA) and the Texas A&M International University started in 1999 to gather information on trade in second-hand vehicles between the United States and Mexico. The aim was to precisely quantify the trade and the environmental impact and to suggest options for political action. The role of NAFTA assumed particular significance. The study comes to the conclusion that restrictions on trade do not make much sense. The reasons given were above all the insignificant scale of the transactions. The study further concludes that the demand for compliance with environmental standards for motor vehicles imported to Mexico would not be enforceable (Giermanski, 1999).

> "We do not have any exact sales figures. This is because, unlike the situation with the export of new cars, the exporters are very small companies." --
>
> *Jang Hye-jeong, Korean Used Car Dealers Assn.*

As is the case with second-hand machinery and equipment, **Korea** also shows a number of peculiarities as far as second-hand vehicles are concerned. Thus the **automobile manufacturers,** Daewoo and Hyundai, actively support the export of second-hand cars in order to stimulate the sale of new cars in the country. According to the Association of Used Car Exporters, Daewoo is planning to export 20,000 of its own models second-hand each year. The existence of an independent association of used car exporters is a strong indicator of the importance of the segment.

The reliability of the present export statistics, however, has its limits. The age structure remains unknown. Apart from this, the average figures per market segment only allow for speculation as to the homogeneity within the market segment. Despite the high average price that is achieved in Russia, a number of low quality cars which are interesting in the sense of this study, were also exported. The relatively low average price for Poland and the Czech Republic could have something to do with the fact that some vehicles that are exported in order to be **scrapped** bring down the average price. Furthermore it appears unclear to what extent all exported vehicles are recorded. Apart from this, no account is taken of trading during transit. Thus it is quite possible that vehicles are first exported to Belgium and then to Africa. Also not recorded, but nevertheless considerable, is trade in vehicles that takes place in the **grey area**. This includes, for example,

- goods smuggled from Japan to Russia,
- cars registered in the USA that are driven in Mexico,
- theft and transport from Western Europe to Central and Eastern Europe (45,000 stolen motor vehicles per year in Germany),
- the disassembly of motor vehicles and declaring them as spare parts for customs,
- conscious or unconscious false declaration of vehicles.

In view of the results of the present study it should be remembered that critical German exports obviously mainly to some countries of Central and Eastern Europe and to Africa in the main. These countries will now be examined in greater detail.

3.3 The status of second-hand vehicles in developing countries and emerging markets

3.3.1 Central and Eastern Europe

For most Central and Eastern European countries it can be said that at the beginning of the nineties a veritable flood of second-hand vehicles were imported from Western Europe. As neither the vehicles produced locally nor the imported vehicles are equipped with the latest filters for harmful substances, total emissions per kilometre are extremely high. It can be assumed that **with increasing age** imported vehicles can lead to similar environmental problems as are already the order of the day in some developing countries.

According to the import statistics for 2001, imports of second-hand cars to the Czech Republic amounted to approx. 100,000 units, as in the previous year. This corresponds to 42 per cent of all imported cars. In the last 10 years 1.14 million second-hand vehicles have been exported to the Czech Republic. The potential disposal costs would amount to 11 million korunas (approx. 10,000 korunas per unit). It would appear that the general objective is an upper age limit of eight years. Thus in the second-hand car segment of the Czech Republic vehicles aged between one and three years tend to play a subordinate role as competitors to new cars. Some 3.5 million cars registered in the Czech Republic have an average age of 14 years. In view of the large number of second-hand imports in comparison with purchases of new cars, the vehicle fleet will not be significantly rejuvenated in the next few years.

Half of the import of second-hand cars is handled on a commercial basis and the other half on a private basis. Czech associations have drawn attention to the extremely low values declared for customs of imported second-hand motor vehicles. In the case of old cars imported into the Czech Republic on a commercial basis the average customs value in 2000 was only about € 750 (Bfai). There therefore arises the question of whether the importers are trying to save money through systematic false declaration of imported second-hand vehicles or whether the actual quality of the imported vehicles in this market segment is even worse than the higher average value of approx. € 2,500 in the German export statistics would suggest. The low average price, however, could also indicate that vehicles are intended to be scrapped in the Czech Republic in order to save the costs necessitated by the **Old Car Regulations** (Altautoverordnung). This is also suggested by the fact that the proportion of second-hand imports among the total number of vehicles imported to Slovakia is only about 10 per cent.

The high proportion of imports in the private sector, however is a certain indication that in the Czech Republic a middle class has developed that can afford a second-hand German car and actually prefer this to a new car.

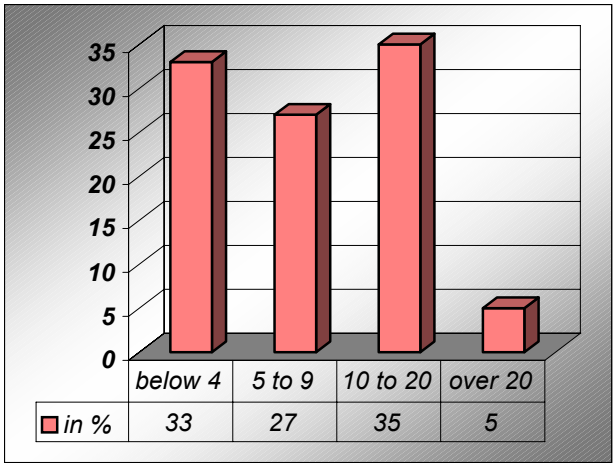


Figure 3.8: Age of the vehicle fleet in Poland
Source: Forum Recyklingu Samochodow

A very similar picture reveals itself in **Poland**. In Poland there is also an interesting interface between the export of second-hand machinery and the export of second-hand vehicles. Thus the **recycling** of clapped out vehicles is usually carried out with the aid of imported second-hand machinery. In Poland there are currently around 1,500 stations for the recycling of wrecks. An average of 200 to 250 old motor vehicles are processed each year. The capacity therefore just about suffices to deal with Poland's own "end-of-life-vehicles“ (ELV) in the country. The fact that more than half of these small companies do not have a permit to trade gives cause for concern. With the exception of catalytic converters, all car parts can be properly disposed of in Poland. Catalytic converters usually have to be exported to Degussa in Germany for processing. (Bfai).

Each year **Bulgaria** imports around 80,000 to 90,000 second-hand vehicles. The leading Bulgarian business weekly, "Kapital", wrote in 2001: "The importers of old automobiles have quite strong protégés and not a single government in the last ten years has managed to change the rules". As a result of the unfavourable age structure of the imports, Bulgaria today has the oldest vehicle fleet in Eastern Europe. The 1.5 million cars registered (approx.) have an average age of some 20 years (Bfai). It is noticeable that Bulgaria, according to German export statistics, neither imports a particularly large number of cars nor particularly inferior cars. This stands in marked contrast to what one would have expected due to the liberal legal conditions and the actual situation locally. This discrepancy leads one to suspect that the second-hand vehicles are either falsely declared or not declared at all. Irregularities actually have occurred in this context which cast doubt on the reliability of the customs statistics. Thus in 1998 Bulgaria, according to its own import statistics, had imported 500 million US$ less from the EU than the EU export statistics indicate. This accounts for 18 per cent of imports. The differences in the German and the Bulgarian statistics, at 108 million US$, are extremely high. This discrepancy is particularly apparent from the example of imported second-hand vehicles (Center for the Study of Democracy, 2000).

3.3.2 Africa

As the export statistics show, the **quality** of the vehicles exported to Africa is **particularly poor**. This particularly applies to West Africa and East Africa. Most countries in this region import more second-hand vehicles than new vehicles. Mercedes, Toyota, Honda, Nissan and Peugeot top the popularity chart when it comes to cars and Mercedes, MAN and DAF when it comes to trucks. Spare parts are usually available for these marques. Apart from this, the garages are specialised in repairs.

Trade in second-hand cars in and to Africa can be a profitable business. Very often the trade is conducted by Africans who live in Europe. The process and the significance of trade in second-hand vehicles with Africa will be explained taking the **example of Benin**. In recent years the market for second-hand cars in Coutonou (Benin) has become one of the biggest trans-shipment centres for second-hand vehicles from Europe. In total about **300,000 second-hand vehicles** a year are trans-shipped in this market. The largest proportion arrives directly by ship from Europe and sold to neighbouring countries such as Nigeria.

To a certain extent importers are at the centre of the second-hand vehicle business. Via a network of well-known "business partners" they have searches conducted in Europe for precisely the kind of vehicles for which there is a particularly large market in Africa. As a rule neither the age of the vehicle not its appearance are important. The bodywork and the engine must last for **at least another ten years** after reconditioning in Africa. Cars are bought which are already more than 15 years old and which would probably be disposed of in Europe. The prices are rarely higher than € 2.000. Minibuses and French marques are particularly popular. Around 3,000 such vehicles are bought by various importers and shipped to Africa at a cost of € 500 per unit.

The so-called "customs yard" is headed by a "good friend" of the President and charges a flat rate of € 150 per car in "customs duty". After general reconditioning the vehicles are then usually sold on in a "roadworthy" condition. A vehicle that has cost € 2.000 to buy usually fetches around € 3,000.

In Coutonou the **Lemon Rule** (see chapter 2) also seems to have proved to be true. Cases are reported where importers have been promised cars by phone which are allegedly in "top condition" and which, on closer examination, have even turned out to be a **"car without an engine"**. Such transactions are usually compensated for by the cars being filled with second-hand television sets and refrigerators during transport, opening up a lucrative side line.

Environmental aspects only play a subordinate role in the import of second-hand vehicles. Although there are apparently limits on emissions in Benin, it is rarely controlled whether they are complied with. Sporadic checks of exhaust fumes by not too well qualified and corrupt police do not bring any major improvement, even though the official fine of € 15 lies at around one third of an average monthly salary. The consequence is a rapidly deterioration in the quality of the air in the centres of African towns and cities and consequently a sharp increase in asthma problems among the urban population. The situation is exacerbated by cheap "adulterated fuel“ from Nigeria, which is sold publicly and in a grand style. According to the Ministry for the Environment, the cost to the country of air pollution is 1.2 per cent of gross domestic product. In Burkina Faso it is said to be 1.6 per cent of gross domestic product and in Senegal even as much as 2.6 per cent of gross domestic product (source:

The Ministry for the Environment of Benin, 2002 and "Schrottautos für Afrika“ –documentary by ARTE TV of 5.8.2002).

A predominantly positive side effect created by the market for second-hand vehicles is allegedly its **impact on the labour market**. Although the average wage is only about one euro a day, 20,000 jobs have been created in Coutonou, feeding a corresponding number of families.

3.4 Estimation of the effects

In contrast to industry, where the sources of emissions are stationary plants, motor vehicle traffic represents **mobile sources of harmful substances**. Emissions of motor vehicle traffic should not be calculated per vehicle but **per route travelled**. The emissions to be taken per motor vehicle depend on the **speed and the style of driving** on the roads.

Motor vehicles largely emit hydrocarbons, nitrogen oxide, carbon monoxide and PM. On top of this comes the emission of lead from vehicles which still run on leaded fuel. Spark ignition and diesel engines differ fundamentally as regards their emission profile. While spark ignition engines have comparatively higher emissions of CO, VOC and benzene, diesel engines emit more NO_x and diesel rust in the form of particles. Emission factors are used to calculate the various emissions.

The following diagrams compare **emission factors** for various vehicle groups and different **exhaust gas standards**. The emission factors shown indicate the real emissions under everyday conditions (roads outside built-up areas)

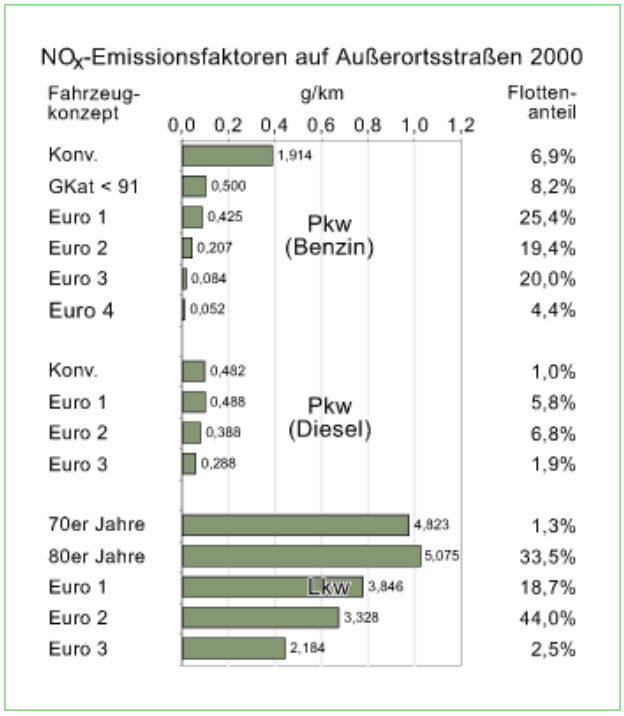


Figure 3.9: **Nitrogen oxide (NO_x) emission factors for cars and trucks on roads outside built-up areas (not motorways), reference year 2000**
Source: Handbuch Emissionsfaktoren des Straßenverkehrs version 1.2 (UBA/BUWAL)

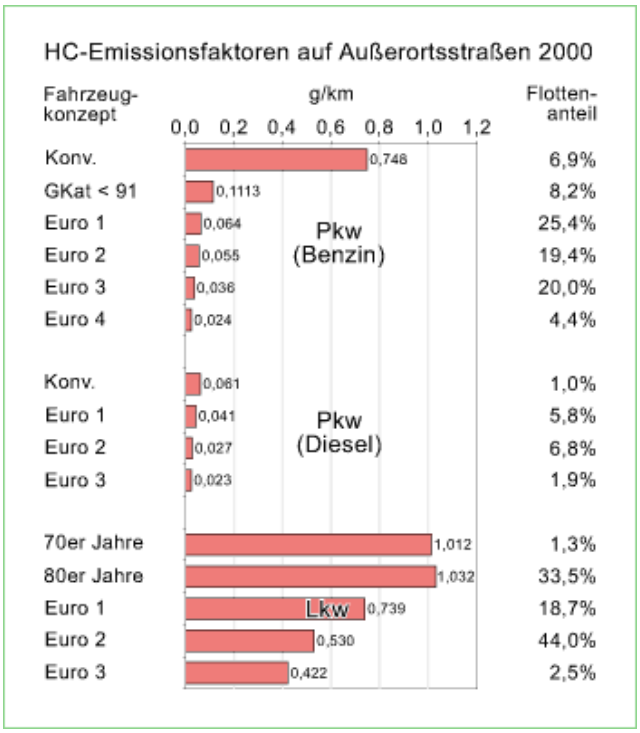


Figure 3.10: **Hydrocarbon (HC) emission factors for cars and trucks on roads outside built-up areas (not motorways), reference year 2000**
Source: Handbuch Emissionsfaktoren des Straßenverkehrs version 1.2 (UBA/BUWAL)

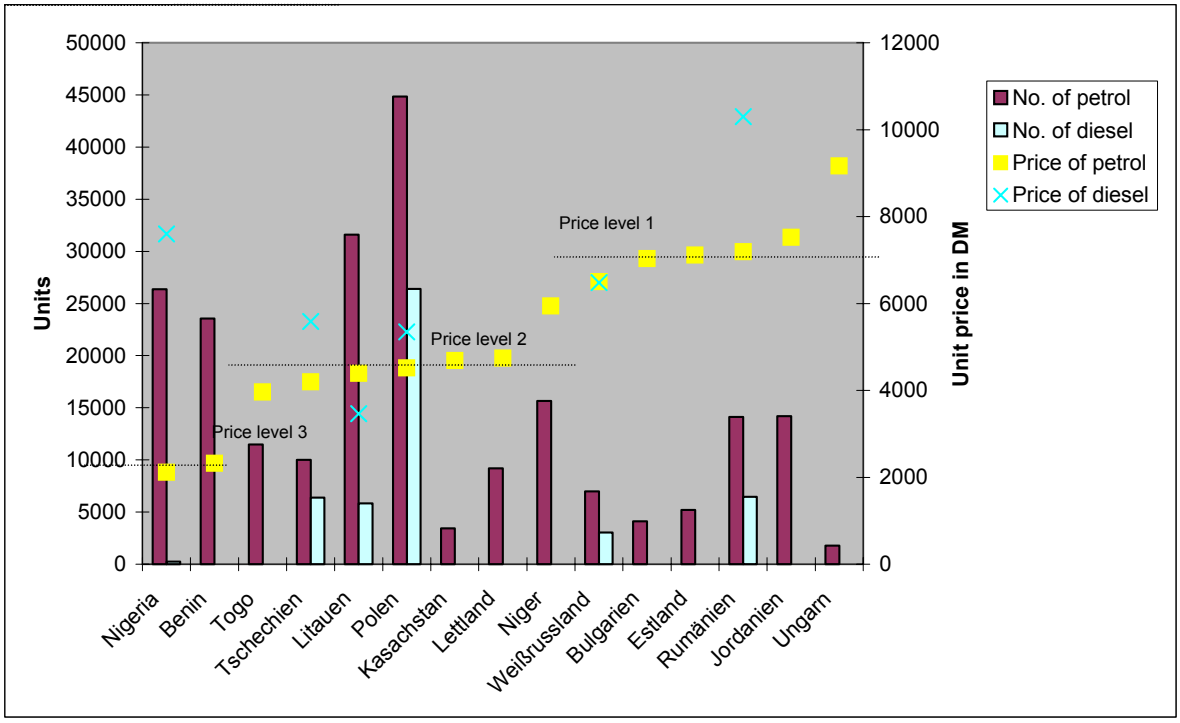


Figure 3.11: **German exports of second-hand cars to developing countries and emerging markets**
Source: Federal Statistical Office

The **export statistics** will first serve as a basis for the estimation of the impact of German exports of second-hand motor vehicles. In order to make a distinction between vehicles for the middle class and vehicles for the upper class and taxis, a price limit of € 4,000 per car is to be introduced for petrol engines and of € 5,000 per car for diesel engines. The biggest importers of German mid-range cars in Central and Eastern Europe are thus Poland, Lithuania, Romania, the Czech Republic, Latvia, Belarus, Estonia, Bulgaria and Kazakhstan. It should be taken into account that this breakdown of countries does not make exact statements concerning the actual new location of the second-hand vehicles as goods in transit are not recorded. It can be assumed that Lithuania, Belarus and the Ukraine, in particular, also buy vehicles with the aim of re-exporting them, mainly to Russia.

The exports can be classified as follows:

Category	Price	Example*	Vehicle concept	Number of vehicles exported**
Price level 3 (petrol, 1500-3000 ccm)	1,100€	Peugeot 405, 12 years old, 180,000 km	No catalytic converter	100,000
Price level 2 (petrol, 1500-3000 ccm)	2,250€	Golf III, 8 years old, 150,000 km	Euro 1	180,000
Price level 1 (petrol, 1500-3000 ccm)	3,500€	Golf CL, 6 years old, 120,000 km	Euro 2	100,000
Price level diesel (1500-2500 ccm)	2,750€	Golf 3, diesel, 8 years old, 170,000 km	Euro 1	85,000
Comparable car	16,000 €	Golf, built in 2002, 55 kW, Super	Euro 4, 158 g/km CO_2 in accordance with Directive 93/116/EC	

Figure 3.12: Categorisation of cars exported to developing countries and emerging markets from Germany according to lifetimes

*current examples from Autoscout24 of 1 January 2003, ** based on 12 months in 2001 and extrapolated to all developing countries and emerging markets (see figures 3.2, 3.3, 3.4)

According to the European Automobile Association, emissions of CO_2 have fallen by an annual average of 1.9 per cent since 1995 and were at 164g/km in 2001 (average for petrol and diesel). Taking the extrapolated figures from Annex 3.1 as a basis, it can be calculated that the vehicle fleet consisting of the **465,000 second-hand vehicles exported in 2001** emits 21.33 g/km more CO_2 than the same quantity of new cars. At an average mileage of **15,000 km per year for each exported vehicle** this results in additional pollution of around 150,000 tonnes of CO_2 per year due to second-hand exports. Taking the comparable car from figure 3.12 as a basis (built in 2002, 158 g/km CO_2), the additional pollution is even as much as 60 per cent higher (240,000 tonnes of CO_2). The world-wide export of 3 million second-hand cars each year would thus result in additional pollution of **1.5 million tonnes of CO_2** - provided that the general conditions are similar.

Similar calculations can be made for NO_x and hydrocarbons with the aid of figures 3.9 and 3.10. The exported vehicle fleet thus emits 0.61 g/km of NO_x and 0.18g/km of HC more than the comparable vehicle fleet of 465,000 vehicles, each equipped with the most modern vehicle concept, i.e. Euro 4 for cars running on petrol and Euro 3 for cars running on diesel. In relation to an average mileage per exported car of 15,000 km there results a theoretical additional pollution of 4,300 tonnes of nitrogen oxide and 1,300 tonnes of hydrocarbons per year.

The additional **fuel consumption** of the exported second-hand vehicles can also be estimated with the aid of Annex 3.3. On the basis of the new measurement procedure, NEFZ, consumption of 8.8 litres per 100 km (1990) has fallen to 7.1 litres (2001). Thus an average mileage of 15,000 km per year results in a total **additional consumption of 70 million litres of fuel** (petrol and diesel). It can also be assumed that this figure is even higher due to the poor maintenance of the vehicles, a lower average speed and a different handling.

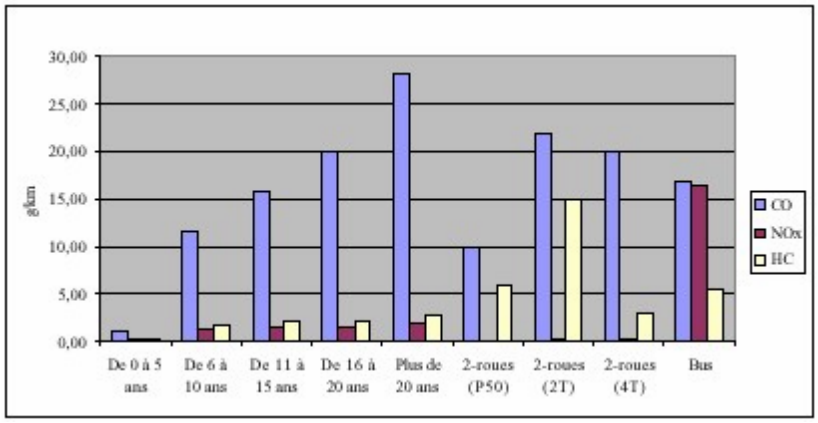


Figure 3.13: Emission factors of the vehicle fleet in Benin depending on age and type of vehicle
Source: The Ministry of the Environment of Benin, 2002

By far the greatest part of the emissions is caused by vehicles of price level 3 which are mainly exported to **Africa**. Assuming, for the sake of simplification, that the vehicles exported to Africa have the heaviest emission of harmful substances, i.e. that they are part of the 6.9 per cent of German vehicles that do not yet have catalytic converters, it can be ascertained that 3 per cent of these vehicles are evidently exported to Africa each year. This assumption seems justified as many countries of destination do not yet have leadless fuels. Thus only cars without a catalytic converter come into question.

So far it has been assumed that the exported vehicles only travel on roads outside built-up areas. This assumption does not seem completely tenable. It must be assumed that the average speed in Africa is sometimes considerably lower. The **case study of "Benin"** will serve as an example again here. Assuming that the vehicle fleet in Benin consists mainly of second-hand imports, official statements concerning its emissions can be used for the present calculation. According to the Ministry for the Environment of Benin, vehicles that are 11 to 16 years emit 2.2 g/km of hydrocarbons, 1.3 g/km of nitrogen oxides and 15.6 g/km of carbon monoxide (figure 3.13). Around 100,000 motor vehicles which are exported each year from Germany to Africa would thus emit 1,950 tonnes of nitrogen oxide, 23,400 tonnes of carbon monoxide and 3,300 tonnes of hydrocarbons at an average mileage of 15,000 km a year. The lower average speed is therefore of particular importance in the case of hydrocarbons. Just the 300,000 vehicles exported to Benin would therefore emit the threefold of these figures per year.

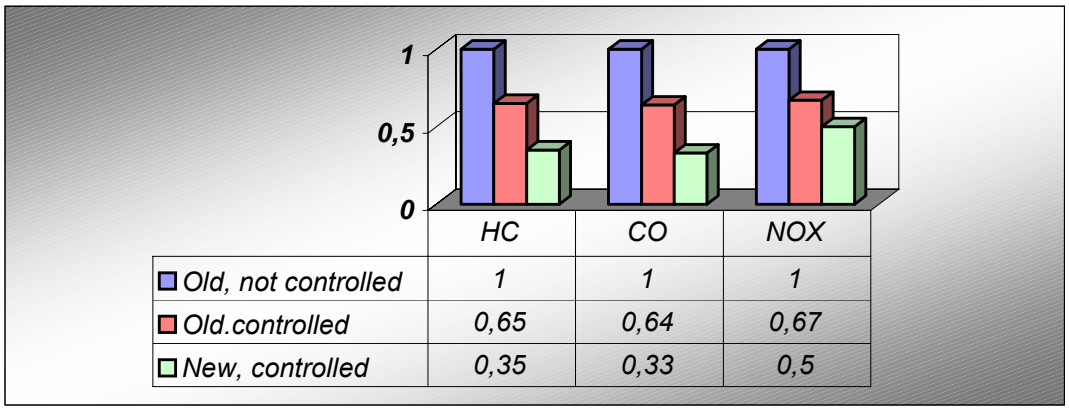
It should be noted that the results so far are all limited to a cubic capacity class in the petrol and diesel area. The actual exports and thus the actual emissions are therefore almost **20 per cent higher** (see figure 3.2).

Finally a brief estimation will also be made of **emissions from trucks**. For the sake of simplification it will be assumed that 60 per cent of all 110,000 commercial vehicles exported in 2001 (see figure 3.5) went to developing countries and emerging markets. Supposing that they are of a "1990s design" (see figures 3.9 and 3.10), that they travel on roads outside built-up areas and that they have an annual mileage of 30,000 km. The commercial vehicles exported second-hand would therefore emit 5,700 tonnes of nitrogen oxide and 1,200 tonnes of hydrocarbons more than a comparable fleet of trucks of the Euro 3 standard. Surprisingly

enough, the emissions are **on the same scale as the emissions caused by second-hand cars**, which is mainly due to the high mileage.

A look will also be taken at the results of other studies. A study carried out in **Taiwan** throws light on the relationship between the age of a vehicle, its fittings and its negative impact on the environment. The following three cases have been distinguished:

- no control of harmful substances, an even distribution of the age of the vehicle fleet over 25 model years,
- control of harmful substances, even age distribution,
- control of harmful substances, actual age distribution,



	HC	CO	NOX
Old, not controlled	1	1	1
Old.controlled	0,65	0,64	0,67
New, controlled	0,35	0,33	0,5

Figure 3.14: Environmental impact of various vehicle fleets in Taiwan
Source: "Older Gasoline Vehicles“, OECD

It can be seen that both the introduction of controls of harmful substances (a 35% reduction) and the reduction in the average age of the vehicles (reducing all harmful substances by a further 50%) bring about a considerable improvement.

4 The energy efficiency of buildings

4.1 Introduction

The third area to be investigated in the context of this study is the energy efficiency of buildings. The subject deserves urgent attention for various reasons:

- The proportion of international building activities accounted for by developing countries has risen from only 10 per cent in 1965 to 29 per cent in 1998 (UNEP).
- The infrastructure of a country usually accounts for more than half of capital investments; the construction industry usually accounts for about 10 per cent of GDP.
- Buildings typically consume one third of a country's energy and about half of its electricity.
- The high potential of the transfer of know-how from the industrialised countries to the developing countries and emerging markets as regards the construction of low-energy buildings is offset by the great risk posed by a maladjusted transfer of consumption patterns.

In view of the sometimes extreme climatic conditions in developing countries and emerging markets it can be expected that inadequately insulated building shells offer particularly high potential for improvement as regards energy efficiency measures. The shell includes everything that separates the inner area of a building from the outside surroundings. This mainly means windows, walls, roofs, ceiling, insulation and the foundations. Measures for improving the energy efficiency of the shell of a building usually only make commercial sense, if they are already taken into account in the planning phase, and the building is not merely upgraded at a later date. If it is considered that buildings often have a lifetime of more than 100 years (see figure 1.1), it becomes apparent that poor planning can, under certain circumstances, lead to a consumption of resources that is unacceptable in the long term. The focus of the following considerations will therefore be particularly on the **energy efficiency of the shells of new buildings** in developing countries and emerging markets. As in the previous chapters, the core area will be an estimation of the environmental impact of maladjusted patterns of technology and consumption.

Unlike the technologies discussed in chapter 2 and chapter 3, the subject of the energy efficiency of buildings in developing countries and emerging markets has already been dealt with in a large number of research reports, investigations and market studies. For this reason **the existing results** that are of interest for this study will be compiled and evaluated. One country in each case will be selected as being representative of various climatic zones (hot, cold, tropical). This country will serve to discuss the specific problems and be used as a basis for making estimations.

That the subject of the energy efficiency of new buildings is an extremely complex one becomes apparent from figure 4.1. In addition to purely technical aspects and the general external conditions, a large number of parties are involved, all of whom pursue their own

interests and who ultimately have a major influence on the actual energy efficiency of the buildings.

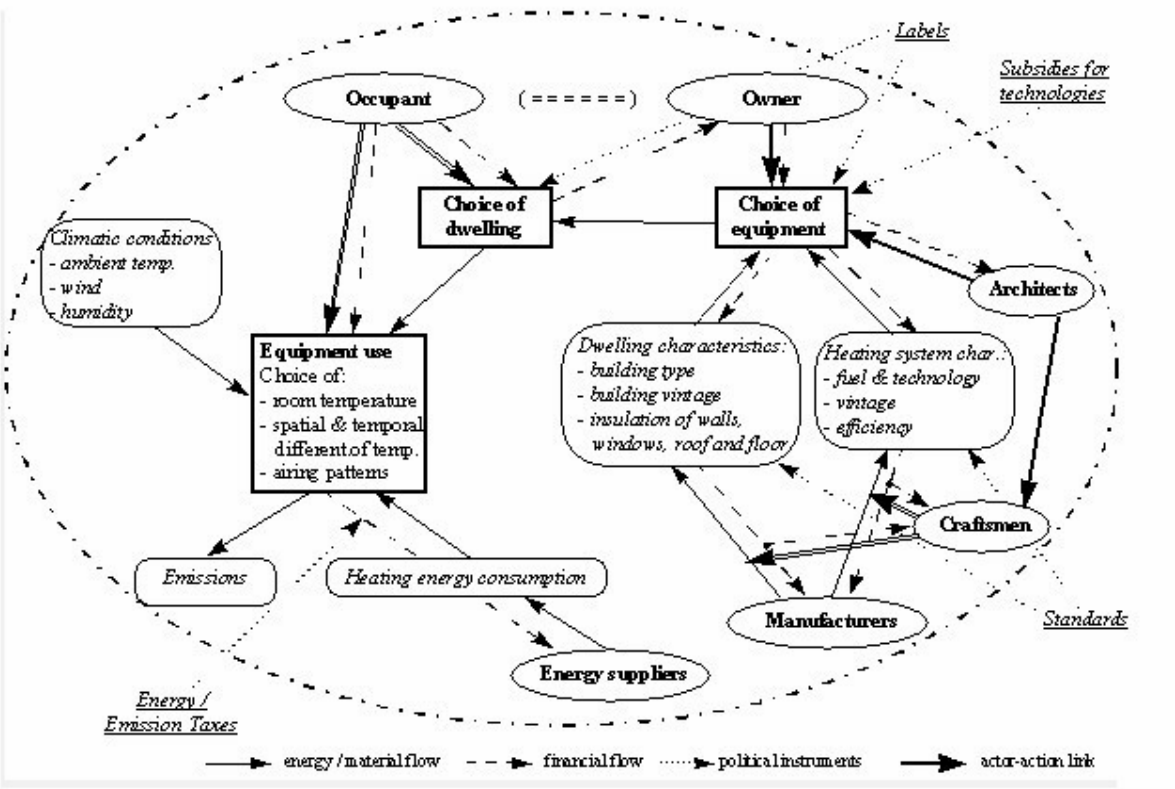
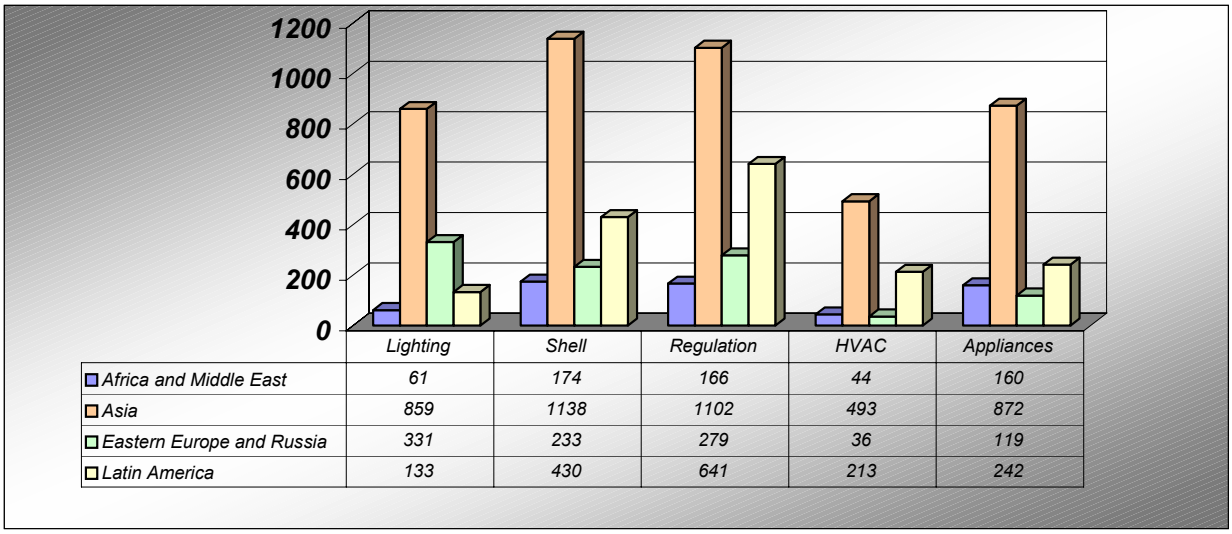


Figure 4.1: Various influential factors and agents in the field of room heating
Source: IER Stuttgart, 1999

Without any doubt an important aspect is the availability and the price of **energy efficient technologies and materials** (ETM). ETM play a certain role throughout the world, as figure 4.2 shows. The biggest market volume goes into the shell. Most of the current demand in this market segment is in Asia. The case studies have therefore been taken from this region. Depending on the growth scenario in developing countries and emerging markets, the total demand for ETM for dwellings and commercial property could be in the region of **13 billion US$** (business as usual scenario) **to 22 billion US$** (strong growth) by 2010.

Buildings that have been constructed using these technologies and materials are usually more comfortable and environmentally friendly and also have lower running costs. However the costs of investment are generally higher.



	Lighting	Shell	Regulation	HVAC	Appliances
Africa and Middle East	61	174	166	44	160
Asia	859	1138	1102	493	872
Eastern Europe and Russia	331	233	279	36	119
Latin America	133	430	641	213	242

Figure 4.2: **The market size of various energy-efficient technologies according to target region**
Source: USAID, 2000 – figures in million US$

According to figure 4.1, there is much scope for political intervention to control the energy efficiency of new buildings. The measures include, inter alia, **building standards** and special **energy standards**. Building standards, and also energy standards, are standards that determine, for example, **the level of energy efficiency** for the construction of new dwellings and commercial premises. Such standards have proved to be an extremely effective and economical means of ensuring energy-efficient construction. They also make it possible to get to grips with a central problem concerning the ownership of the buildings. The owner of commercial premises, namely, is rarely the occupant (see also figure 4.1). The owner consequently has only little interest in lowering the running costs through expensive energy efficiency measures. Consistently enforced energy standards, on the other hand, encourage owners to use ETM.

Standards and guidelines for the energy-efficient design of new buildings are now to be found **in more than 40 countries**. In China, South Korea, the Philippines, Thailand, South Africa, Saudi-Arabia, Hungary and the Czech Republic, among other countries, the guidelines are binding for at least some of the buildings. The "Berkley Laboratory“ has attempted to quantify the possible energy savings achievable through the application of energy norms and standards throughout the world, and thus the possible reductions in CO_2.

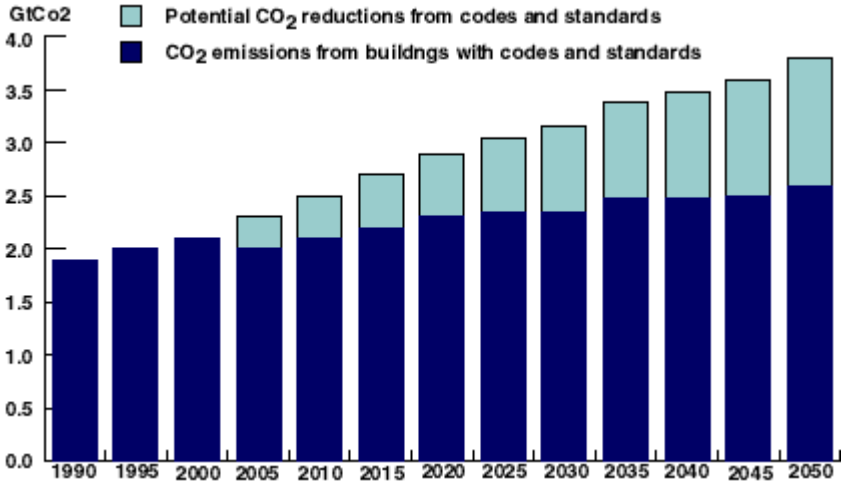


Figure 4.3: Estimation of CO_2 reductions world-wide through the application of energy guidelines and standards
Source: CBS Newsletter, summer 1998, page 5

On the one hand the enormous potential for saving becomes apparent. On the other hand, however, such estimations also indicate certain defects. This is because they also raise the question concerning the "**quality of the standards**" and, even more importantly, concerning the **costs for implementing the standards**. It is important that the standards are defined in such a way that they both take account of local climatic conditions and the general conditions. The costs must also be "reasonable" and the standards enforceable.

Energy standards in Singapore

Singapore is leading the way forward as regards energy standards in South-East Asia. For a long time the subject of energy efficiency had no priority when it came to designing a building. In the meantime the government, after some good initial experiences, has even gone as far as to impose even tougher energy standards for buildings. It is estimated that one third of energy consumption in Singapore is accounted for by residential and commercial buildings in view of the immense expenses for air conditioning. With new energy standards the government intends to **save up to one quarter of the energy consumed** by air-conditioned buildings. The new concept for the thermal transfer of the shell (Envelope Thermal Transfer Value, ETTV) replaces the old standard of Overall Thermal Transfer Value (OTTV). The limit for thermal transfer suggested by the "Building and Construction Authority" (BCA) is 35 watts per square metre (OTTV standard: 45 W/sqm). In addition to improvements in the walls and the roof, this is particularly to apply to windows. In Singapore builders have not extensively exhaust the technical and commercial possibilities offered by insulated glazing (Bfai).

4.2 Case studies

4.2.1 The Philippines – tropical climate

The Philippines will serve as an example of a developing country with a tropical climate. In the past this Asian country has been characterised by **very buoyant activity in the construction of new dwellings and offices**. On top of this the Philippines, due to the strong US American influence, have attempted to imitate the "American way of life“. This may have been done uncritically, without taking account of the country's own climatic conditions when planning of new buildings.

According to the Philippine Office for Statistics, the rate of growth of the Philippine construction industry between 1992 and 1995 was 49.8 per cent a year. In the same period **4.7 million sqm of new commercial premises** were built on average. The largest proportion of this (2.7 million sqm per year) is accounted for by Greater Manila. Although the **Asian financial crisis** resulted in a considerable decline in building activity, it can be assumed that as soon as economic growth steps up again there will be similar activities for the construction of new buildings as before the crisis. Then projects will probably be implemented which had already been planned and were merely postponed. This assumption seems well justified. In view of the low interest rates the real property markets in Asia have already picked up. The Thai share price index for real property, for example, grew by 72 per cent in 2002 (source: FAZ of 31 January 2003). In interviews with Philippine property developers it was assured that the period of economic crisis without any major building activity is being taken as an opportunity to press forward with new projects.

Various international research projects and studies have been concerned with the energy efficiency of the Philippine construction industry. The aspects relevant for the present study will be summarised below.

The study “**Energy efficiency policy and technology transfer: A Hawaii-Philippines Case Study**” carried out by the US federal state of Hawaii in 1999 investigates inter alia the present building standards in the Philippines and compares them with the US American and international guidelines. It estimates the savings that could be achieved if the present guidelines were implemented and what potential for savings through the application of tougher standards for buildings.

Two thirds of all building activities concern smaller buildings with a useful area of less than 1,000 sqm. However, according to Philippine statistics, the Philippine guidelines for shells are currently only apply to relatively large, air-conditioned buildings with a peak load in excess of 175 kW . Under local conditions this roughly corresponds to a useful area of 2,000 sqm. The study mentioned therefore first defines a **reference building** typical for the Philippines to which the guidelines would be applicable. This 10-storey office block has 15,560 sqm., 49 per cent of the outside wall consists of single-glazed, uncoated windows. Further details concerning the building are defined.

The guidelines applicable to this building are based on the OTTV method (Overall Thermal Transfer Method), which describes the quality of the outside walls (unit W/sqm). In order to obtain planning permission for the reference building, this figure would have to be below 48

W/sqm . Annex 4.1 shows the calculation of the OTTV for the reference building and, at 559 W/sqm, arrives at more than tenfold the permitted maximum.

Various methods are suggested as to how the limit could be achieved. Double glazing, window coatings and other window/wall ratios are used (see DblTntSS14 and SglClrSS08 in figure 4.4). Without the improvements mentioned, the reference building would have an annual electricity consumption of 4.4 GWh. The energy intensity of the building therefore lies at 280 kWh per year and sqm. The study comes to the conclusion that the application of the "national standard", i.e. with the said improvements in comparison with the reference building of the conventional style would result in **energy savings of between 17 and 22 per cent**.

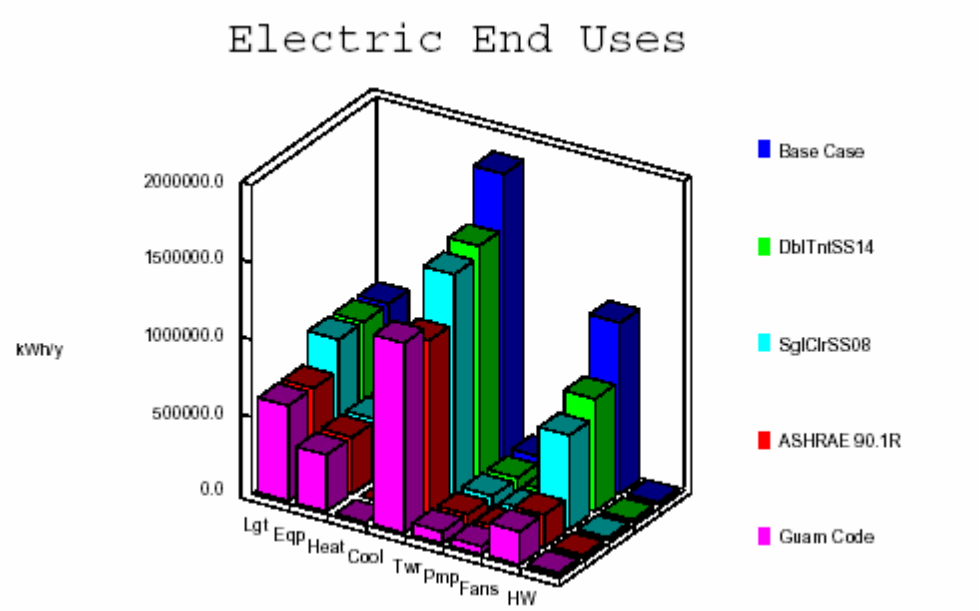


Figure 4.4: **The potential for saving energy by taking account of various energy standards**
Source: "Energy efficiency policy and technology transfer: A Hawaii-Philippines Case Study", 1999

If the **US American ASHRAE standard** 90.1-1989R were used for the reference building, about 43 per cent of the energy could be saved. The study also calculates possible energy savings if the **Guam Code**[4] were to be used. Guam has developed energy guidelines which are **typical for tropical climates** and which are also relatively easy to apply and enforce. The use of the Guam Codes would, among other things, result in the use of a specially coated glass and a better insulation of the roof. Buildings constructed according to the "Guam-Code" would use **41 per cent less energy** than the reference building.

All codes examined thus drastically reduce the energy needed to cool the rooms. Taking an electricity price of 4.28 pesos/kWh, the owner of the building in the example would save

4 www.elay.com

between 80,000 and 200,000 US$ in electricity costs each year.

Assuming that the volume of construction seen in the middle of the 90s will be achieved again (i.e. a commercial building of 290,000 sqm as an annual average), the consistent application of energy codes could save substantial volumes of energy. With savings on the scale of 60 kWh per year and sqm for large office premises through the existing standard (a 22% reduction vis-à-vis conventional building methods) 13 GWh per year could be saved in this area alone. If these savings were made for all types of buildings, **165 GWh per year could be saved** throughout the country as a whole (see figure 4.5 and Annex 4.2). The potential for savings if other codes were to be applied is therefore about twice as high.

	Small	Medium	Large	Total gWh/y
Office	53	22	13	88
Retail	14	4	2	20
Hotel	2	0	0	2
Apartments	29	5	2	36
Other	15	3	2	20
Total	111	35	19	165

Figure 4.5: **Possible energy savings through using the "Philippines Energy Code“ in GWh/year**
Source: “Energy efficiency policy and technology transfer: A Hawaii-Philippines Case Study”, 1999

Depending on the type of power station used to produce the reduced electricity requirements thus calculated, savings in greenhouse gases of 0.5 kg CO_2/kWh (natural gas, combined cycle plant) and about 1 kg/kWh (on a coal basis) could be achieved, This means up to **165,000 tonnes** in one year and **more than 9 million tonnes of CO_2 after a total of 10 years** if the existing standards were consistently applied to all buildings and assuming the same building activity.

Furthermore the application of energy codes would also have significant effects on electricity requirements. Thus peak demand in the base case could be reduced from 1,250 kW or 80 W/sqm to 830 to 1,050 kW by applying the various energy codes. If a **reduction of peak demand by 20 W/sqm** could be achieved for all new commercial premises, this would make it possible to avoid the construction of a 100 MW power station every two years.

A further study of the International Institute for Energy Conservation (“**The Market for Energy Efficiency Technologies and Services in the Philippines**”, 1998) examines the energy efficiency of shopping centres and office blocks in the capital, Manila, and makes calculations concerning the potential for savings by improving the general energy efficiency of the buildings.

According to the study, the 30 biggest office blocks and shopping centres consume an average of 18.4 million kWh of electricity each month (1997). The average electricity consumption of the ten biggest shopping malls lies between 500,000 and 1.4 million kWh per

month. That of the ten biggest office blocks lies between 230,000 kWh and 600,000 kWh. A reduction in the electricity consumption of these 20 office blocks by only 10 per cent would save almost 40,000 barrels of oil each year (approx. 700,000 US$). Manila's electricity utility, MERALCO, estimates the consumption of electricity of all commercial buildings in the capital at 5.8 billion kWh per year. This corresponds to one third of the total consumption. The utility estimates the potential for saving energy expended on cooling rooms in the commercial sector at 39 per cent.

Further investigations have revealed that nine out of ten office buildings or shopping centres have already installed **energy-efficient technologies**. These, however are usually limited to very simple measures. Only in the oldest of the buildings investigated (built in 1988) are ETM of no significance. This does show that energy efficiency seems to be increasingly playing a role in the case of new buildings. However the survey also shows that there is sill considerable potential for saving - one that can even be achieved with limited financial resources.

It is reported that there are only very few new buildings with energy-efficient technologies whose potential for savings will only pay off in the long term. Furthermore the study has revealed that at least five of the owners of the building complexes are working on new projects and planning to construct at least six further complexes. Other studies confirm this trend. SM Prime Holdings Inc. and Robinsons Land Inc. plan to build two shopping centres per year **in the American style**. The National Shelter Strategy intends to build roughly 800,000 dwellings between 1999 and 2004. Filinvest Land and Fort Bonifacio Development Corporation are planning to build further office complexes.

Another study within the framework of the "**ASEAN-U.S. Project on Energy Conservation in 1988**" also confirms the urgent necessity for energy-efficient measures in Philippine office buildings and on the basis of 11 of the office complexes examined has calculated **savings in electricity consumption of 15 per cent** simply through measures which are either low-cost or involve no costs at all.

An interesting case study is the **building of the Asian Development Bank** (ADB) in Manila. It shows a potential for saving energy in commercial premises which is virtually inexhaustible. When the building was constructed in 1980 it was considered to be a "particularly energy-efficient building" in the sense of a **demonstration project** and received an award from the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) which is responsible for codes. Nevertheless between 1993 and 2000 a number of further energy-efficiency measures were taken that reduced the building's consumption of energy by another 40 per cent. Investments of 3.5 million US$ were offset by an “internal rate of return” of 25 per cent and total savings of 30 million kWh (IAEEL newsletter 1-2/00, "Asian Development Bank Lights the Way in Efficiency“).

But even this enormous potential causes no one to act. The Philippine government estimates that between 1998 and 2008 only about 36.5 million US$ will be invested in "demand side management“ and energy efficiency measures. Half of this will be provided from private resources and half from public funds. The investments therefore account for only 0.14 per cent of the amount invested in the country's energy sector in this period.

It should also be mentioned that the observations exemplary for the Philippines can also be regarded as being largely **representative** for the entire ASEAN region and possibly even for tropical regions throughout the world.

4.2.2 China - cold zones[5]

Due to the enormous building activity in China the energy efficiency of new buildings is a particularly important subject, as the following details show:

- In 2000 the Chinese building industry generated a GDP of 71 billion US$. This corresponds to 6.6 per cent of the entire gross domestic product.
- In 2015 more than 50 per cent of all buildings will have been built after 2000.
- Almost half of the existing municipal dwellings in 1998 were built in the 90s.

At the beginning and in the middle of the 90s there was a great deal of building activity in China in the field of municipal office and administration blocks, hotels and retail areas. Between 1991 and 1998 an average of some 300 million sqm were completed each year in this area. Since 1998 the focus has clearly shifted towards the construction of urban dwellings. This comes as no surprise as in many towns and cities the building activities were not in line with demand. In the case of office blocks vacancy rates of 50 per cent were achieved at times.

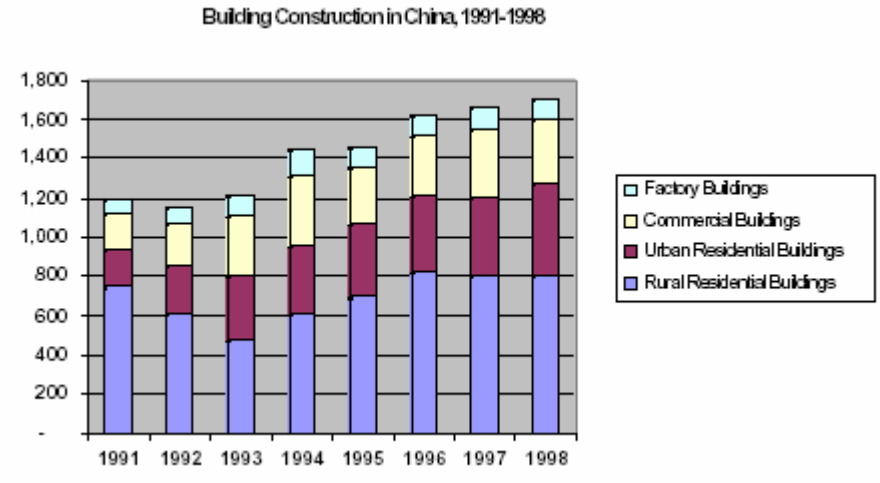


Figure 4.6: The type of building activities in China and their extent (in million sqm completed)
Source: China Statistical yearbook 1991-1998

The tenth five-year plan (2001 – 2005) of the Chinese government stipulates the **use and promotion of new building materials**. It can therefore be assumed that planning laws have

5 If nothing to the contrary is mentioned, the data for the following case study is taken from a discussion paper of the World Bank ("**China – Opportunities to Improve Energy Efficiency in Buildings**").

been amended and that the use of new building materials will consequentially tend to increase. The new building materials include, inter alia, PVC windows and doors, varnishes and paints, glass, ceramics, cement, prefabricated parts and well insulated floor coverings (Vinck). It is planned to produce these materials in China itself. There are therefore planning figures concerning production figures and quantity listing that are to be realised in several stages. Due to the availability and the prices of the materials, there are currently some differences vis-à-vis Europe in the use of the building materials. Much lower costs for natural stone, for example, will ensure that this material will also be widely used.

The decision regarding the use of the materials is usually taken in so-called "Design Institutes“ which play an important role in the Chinese building trade. In terms of their planning tasks, these state organisations are comparable to a certain extent with architecture and planning offices in Western Europe.

According to the Chinese Office for Statistics, the Chinese market for all types of building materials was worth almost 52 billion US$ in 1999. The market for **energy efficient building materials** was worth **9 billion US$** in 1999 (Industry Sector Analysis, US Foreign Commercial Service). Only material to the value of 300 million US$ is being imported at present. A survey among German suppliers of building materials who have already been active in China has revealed that 60 per cent of the respondent companies expect an improvement in conditions for market access due to China's accession to the WTO. At all events it is likely that the reduction in customs duties will bring about an increased use of modern, energy efficient building materials from industrialised countries (Vinck).

Despite new regulations and the increasing availability of new materials, the **quality of new buildings has usually remained inferior to this day**. It is true that the Chinese government has introduced **energy standards** and has even toughened them up during the course of time. However they are still well below the figures for comparable regions in North America and Eastern and Western Europe. Besides this, they are not usually complied with. Most Chinese buildings - including new buildings - are either in the conventional, inefficient design of the 50s or are somewhere between the conventional design and the code of 1986. There is only a small number of buildings that comply with the code of 1995. It is estimated that only 10 to 20 per cent of offices and commercial premises reach the international standard. The proportion of higher-quality projects is much greater in the east than it is in the west of the country.

	Roof	Walls	Windows
China, conventional design	1.26	1.70	6.40
Energy efficiency code of 1986	0.91	1.28	6.40
Energy efficiency code of 1995	0.6-0.8	0.8-1.1	4.0
Germany**	0.22	0.45	1.30
Russia *	0.57	0.77	2.75
USA*	0.19	0.45	2.04
Canada*	0.4	0.38	2.86

Figure 4.7: International comparison of thermal standards for building shells – thermal transfer coefficients for roof, walls and windows in w/sqm K
Source: World Bank Discussion Paper, ** from EPISODE, *in comparable region

Most of the heat of buildings in China is currently lost through the **outside wall**. This heat loss is **three to five times as high** as the heat loss of North American or North European buildings (see figure 4.7). The loss of heat through the windows is about twice as high. On the whole commercial buildings in China use **50 to 100 per cent more energy than buildings in Northern Europe,** even offer much less living comfort at the same time.

The poor quality of the buildings is also reflected in the heating costs. China currently consumes about 130 million tonnes of coal equivalent each year to heat municipal dwellings and commercial premises (estimations of the Chinese "Ministry of Construction“ MOC). These accounted for roughly 29 per cent of the total 33 billion sqm of living space and commercial space available in 1998. Experts have estimated that an increase of about **10 per cent in the costs of investment for new buildings in China would result in a 50 per cent reduction in the consumption of energy**. If all new buildings had even half their present energy consumption as of immediate effect, the municipal dwellings or commercial premises constructed each year would need 5.5 million tonnes of coal equivalent less in heating energy (on a calculation basis of 800 million sqm per year constant). 15 million tonnes of CO_2 would be saved each year. This means that in the next 10 years 300 million tonnes of coal equivalent or more than **800 million tonnes of CO_2 emissions** could be saved.

The tenants of Chinese dwellings and commercial premises will probably also be interested in measures to improve energy efficiency. In the North of China heating costs often eat up 15 to 30 per cent of household income. The question is whether the prices of real property, which are high for conditions in China (around € 20,000 Euro for an apartment of 70 sqm in the suburbs of Peking), could accommodate another 10 per cent increase.

Apart from this, the subject of **energy efficient room cooling** is playing an increasingly important role in China. In 1999 40 TWh of electricity was used for this purpose. While in other countries the problem is often to lower the expensive peak loads in the generation of electricity, in China the question of room cooling is initially a question of achieving a considerable improvement in the energy efficiency of the building shell.

4.2.3 Pakistan – hot climate

The direct and indirect consumption of energy of households in Pakistan accounts for 70 per cent of the country's total energy consumption and thus offers substantial potential for savings. The energy consumption of dwellings is characterised by considerable differences between incomes and location (town or city, countryside). In Pakistan measures to reduce the consumption of energy do not yet play any role in the design of new houses and offices. Room cooling currently accounts for about 5 per cent of privately consumed electric energy in Pakistan. It is intended that by 2020 air-conditioning systems will use 3.359 GWh of electric energy each year.

Most of the heat in summer is absorbed by the roof of a building. For this reason the **ALGAS study** (Asia Least-Cost Greenhouse Gas Abatement Strategy) has made feasibility studies for **improvements to the roof insulation of buildings in Pakistan** (Alternative Energy Development, 1998). In the study it is assumed that there are no major technological obstacles to drastically lowering the inside temperature of a building through roof insulation. The material to be used is intended to be simple styrofoam. This is produced in the country itself and can be laid by trained workmen. It is estimated that the energy consumption of buildings could be cut back by **45 per cent** through this measure alone. For further calculations it is assumed that an improvement in roof insulation could realistically become a reality by 2020 among 35 per cent of the urban upper classes, 15 per cent of the urban upper middle classes and 25 per cent of the rural upper classes. For buildings in commercial use the maximum **thermal transfer** is considered to be 30 per cent. On the basis of this assumption the ALGAS study expects that a total of **1,070 GWh of electric energy** could be saved. This would roughly correspond to the emission of 1 million tonnes of CO_2. The costs of investment of approx. 261 million US$ would be offset by profits of 243 million US$. This means that 1.92 US$ would have to be raised in order to avoid the emission of one tonne of CO_2. The feasibility studies are explained in Annexes 4.3 and 4.4.

The upgrading of roof insulation has poor results in comparison with other measures to prevent greenhouse gases (e.g. energy-efficient lighting, highly efficient boilers). However this example shows that **the rehabilitation of buildings** can also be an interesting proposition for the reduction of CO_2 emissions in developing countries and emerging markets.

An analysis carried out by the Berkley Lab shows that improvements in the energy efficiency of buildings in Pakistan will avoid **20 per cent of the predicted energy demand** in the next 20 years and could thus lead to savings of 10 billion US$.

5 Evaluation of the results

5.1 Market development

5.1.1 Second-hand machinery and equipment

In the past, a number of reasons has made the trade in second-hand machinery and equipment difficult. The costs for dismantling, transport and reconstruction, the heterogeneous distribution of factors and also the sometimes restrictive legislation are all arguments that speak against trade in second-hand machinery and equipment. In addition to this there are the psychological factors. Thai society, for example (and not only Thai society), feel a general disdain for things that are second-hand as it has a connotation of exaggerated parsimony, a low degree of personal achievement or even of rejection. A further psychological factor is the buyer's often justified fear of poor quality.

In the past a particularly important obstacle to trade in second-hand machinery and equipment was a lack of market information. As certain suppliers constantly sell non-standardised products it is much more difficult for buyers to obtain an overview of what is on offer and to specifically purchase the right machinery or equipment to satisfy their requirements.

Due to the internet, improved communication techniques, the construction of databases etc. the latter problem, in particular, is increasingly being overcome. One of the major obstacles to trade in second-hand machinery and equipment is therefore losing more and more of its significance. At the same time further international trends are promoting trade in second-hand machinery and equipment. These include, for example, globalisation, rapid technological development, structural changes in the structure of international demand and the international division of labour, improved possibilities for transport and also privatisation and the opening up of more and more market segments.

For the individual agents in the market for second-hand machinery and equipment the trade has considerable advantages.

It is undisputed that the most important motivation for buyers of second-hand machinery and equipment are the **savings in the capital outlay** in view of the general lack of financial resources. A bottle filling machine transferred from the USA to China, for example, costs 2.3 million US$ second-hand instead of 20 million US$ new (Journal of Commerce). The hurdles mentioned above are not so important. A **life-cycle analysis** is only carried out in very rare cases. The possible consequential costs are not therefore taken into account when making a decision to purchase. Another important reason for the purchase of second-hand equipment is the **time saved**. While the construction of a new nitrogen plant takes three years, a second-hand plant can already be ready for use in 18 months (Journal of Commerce). The international supplier of second-hand machinery and equipment, UPE Universal Process Equipment in Berlin, confirms that: "*The great advantage of purchasing second-hand machinery is its immediate **availability**. Thus around 30 per cent of the customers who contact us wish to make substitute investments.*“ (Handelsblatt of 20.April 1999). Moreover

second-hand machinery is often preferred because it has already **proven its worth** and tends to be **more labour-intensive.** Due to its complexity, modern German machinery often finds no demand in countries at a lower stage of economic development.

In the industrialised countries it is mainly the high **overall costs** and the quality demanded that force companies to purchase increasingly modern machinery at a faster and faster rate. The old machinery then has to be **disposed of at low cost** or may possibly be returned to the dealer as a down payment for new machinery. At the same time second-hand machinery and equipment comes onto the world market when **capacities** have to be reduced in industrialised countries. A relatively new trend is for users of machinery to include a "remaining value" for a piece of machinery or equipment in their feasibility calculations, i.e. to specifically offer a piece of equipment for sale instead of scrapping it immediately. The reason for this is, among other things, the general growth in the segment for second-hand machinery due to an improvement in **information and transport**.

General	Buyers	Manufacturers	Users of machinery	Policy
Globalisation Rapid technological development Structural changes in demand and international division of labour Increased privatisation New markets opening up Improvement in transport Local economic growth Better information (e.g. the internet) No more customers in Germany Corruption and smuggling Economic crises Little interest from environmental groups	Savings in the capital outlay Time savings for investments along with a rapid expansion in production The "good reputation" of German products Higher standards and no finance needed Often no standards or existing standards not enforced More suitable than "high tech" Machinery has "proved its worth" Limited capability for absorption No market overview No life-cycle analysis	Customer service Customer loyalty Low marketing costs Low-cost way of opening up new markets Not the same market as for new machinery Demand exceeds supply	Excess overall costs Output of the machinery is no longer sufficient Reduction in surplus capacities Rapid and low-cost disposal Written off in the accounts "Test market“ (investments) New standards regarding emissions and efficiency Opening up new markets through relocation or foreign investment	**Country of import:** Achieving economic growth Loopholes **Country of export:** Restrictions rare Interest in profit maximisation for indigenous companies High environmental standards

Figure 5.1: Reasons for the export of second-hand machinery and equipment to developing countries and emerging markets

Regarding the general political and legal conditions for trade in second-hand machinery and equipment a differentiation must be made between the countries of export and the countries of import. The exporting countries generally have no interest in restrictions because exports of second-hand machinery and equipment not only produce income, but also reduce environmental problems and save disposal costs. However, apart from a few exceptions, there is no active policy of promoting exports, as would be conceivable for the reasons

mentioned. On the whole the situation here is characterised by passivity.

The **policies of the countries of import** are generally characterised by a high degree of heterogeneity and also by inconsistency (in a chronological dimension and also in relation to the actual contents of the legislation). As a rule the import policies mainly have the aim of achieving **economic growth** and only inhibit the import of second-hand machinery and equipment if this would harm indigenous industry. Considerations as to the environmental impact and a possible failure to keep up with technological progress do play a role, but numerous **loopholes** provide a way out, especially in polluting sectors (examples: China, India). In the opinion of experts such as Navaretti, the general legal conditions are usually ineffective as they prevent the adjusted selection of technologies. There are practically no or only superficial import policies that are specifically geared toward environmental requirements.

In many cases the connections between environmental policy and trade in second-hand machinery and equipment tend to be indirect. If the government of a country, for example, toughens up **emission standards** without simultaneously offering methods of financing a technological adjustment, companies often have no other option than to resort to second-hand machinery from abroad. However it also often happens that emission limits do exist, but they are **not consistently enforced** by the authorities or they can be circumvented through bribes. In this case second-hand machinery and equipment with poorer emission readings is often "sufficient".

In the case of large plants which obviously have a polluting effect the critical forces seem powerful enough to prevent a transfer. Although this cannot be proved in terms of statistics, there are examples where the local and/or international resistance of internationally active **environmental groups** has proved successful. Thus the transfer of a second-hand chlor-alkali plant from Denmark to Poland in 1994 was stopped by the efforts of Greenpeace, among others. Such cases, however, are an absolute exception. Not only are most second-hand exports not recorded in terms of statistics, but they also fail to arouse any marked interest among environmental groups. However in their total effect the exports cause quite a substantial degree of pollution, as the results of this study show.

The question of whether companies deliberately relocate or sell their equipment abroad due to stricter **environmental legislation** is one that has given rise to much discussion. This may be the case in some industrial sectors. Thus a large number of leather factories, for example, have been closed down in the OECD countries due to tougher environmental legislation. At the same time the vacuum thus created has been filled by developing countries. Between 1980 and 1990 the leather exports of Pakistan rose by more than 100 per cent. However this does not appear to be a generally applicable trend. The costs for the necessary reduction in harmful substances in most industrial sectors are usually 0.5 per cent of the value of production and rarely more than 3 per cent. (World Development Report). Considering that relocation is usually both a protracted and a highly complex process, it seems questionable whether the resulting costs do not offset the additional expenditure necessary to keep within the emission limits and are the sole reason for relocation. This does not naturally mean that the second-hand machinery and equipment transferred does not produce any negative impact on the environment at the new location, as the results of this study also show.

5.1.2 Second-hand vehicles

Many of the considerations mentioned above also apply to international trade in second-hand vehicles. It is true that developments in the field of information technology play a lesser role here, but many of the trends previously mentioned are causing rapid market growth in this area as well. Thus for Germany the opening up of the markets of Central and Eastern Europe has meant substantial growth in the trade of second-hand vehicles.

As cars are usually consumer goods, the motives which are of importance for buyers of investment goods are supplemented by other factors. Emotional aspects, such as the need for "status symbols" and the concomitant buying attitudes of the middle classes, are of relevance in this context. Differences between the market for second-hand machinery and equipment and the market for second hand vehicles can certainly be found in other areas as well. Thus vehicle manufacturers apparently have an even greater interest in exporting their makes second-hand than do manufacturers of machinery (Daewoo being an example). On the whole, however, the picture is similar, also as far as the market participants are concerned. Lower costs of investment (in comparison with new vehicles) are certainly the most important incentive for buyers of second-hand vehicles to become active in this market. On the other hand sellers of second-hand vehicles are increasingly recognising the opportunities brought by international trade. Vehicles that have become not saleable in Germany still find customers willing to pull out their chequebooks in developing countries and emerging markets.

General	Buyers	Sellers	Manufacturers/dealers	Policy
Growing world trade Improved information Improved transport	Growing purchasing power of the middle classes The status symbol of owning a "German car" Low repair costs Standards not available or not enforced	Fear of the TÜV High repair costs Comparatively high per capita income The status symbol of owning a "new car" Disposal	High profit margins More space for new vehicles	**Country of import:** At present only few restrictions Loopholes **Country of export:** No comment TÜV Old Car Regulations (Altautoverordnung)

Figure 5.2: Selected reasons for the increased export of second-hand vehicles to developing countries and emerging markets

Some of the countries of import for second-hand vehicles have produced legislation. As is the case with second-hand machinery and equipment, however, this legislation is heterogeneous in nature and its enforcement is often not guaranteed. It becomes clear here that ecological considerations do in fact play more of a role in the drafting of import policies than is the case with second-hand machinery and equipment.

One aspect which is of importance as regards German exports of second-hand vehicles are the **Old Car Regulations (Altautoverordnung).** Whether these regulations have resulted in

increased exports of second-hand cars, particularly to Eastern Europe, is something that cannot be unequivocally stated on the basis of the data available. The relatively low savings in the costs of disposal are probably not the sole reason for export. The **differences in the price level of second-hand cars** are certainly more important. Thus vehicles which it would not be worth repairing in Germany can be repaired at good value in countries where wages are lower and where they achieve a higher price. However, it is also certain that ultimately the cars exported to the importing countries can be disposed of in accordance with local environmental standards. Thus in this way the countries of origin (Germany) get rid of their problems through export, so to speak. The objectives of the Old Car Regulations are thus circumvented by exports to quite a considerable extent.

5.1.3 Non energy-efficient methods of construction

One of the main reasons for **non energy-efficient methods of construction** in developing countries and emerging markets is that only in very rare cases is the constructor also the user of the building. The building client is usually only interested in providing plenty of useful space at as low a price as possible. Thus a kind of vicious circle has developed. Building clients complain that ETM are either not available or are too expensive. Manufacturers of ETM, on the other hand, complain that demand is too low. They cannot therefore lower the prices. Users of buildings usually have only little influence on the fittings in the useful areas. If their financial resources allow, they often prefer a "western lifestyle" as opposed to an energy-efficient solution. Apart from this, public policy often fails to lay down energy efficiency standards for buildings or sets unsuitable standards. If standards are set, these are not consistently enforced.

General	Building client	User of building	Manufac-turer of ETM	Policy
Economic crises General shortage of dwellings or office space Lack of information	Short-term savings in costs Does not pay for heating and electricity No energy-efficient materials available	Desires a "western lifestyle" Often has no influence on architects Little purchasing power No life-cycle analysis	Little demand Little purchasing power in developing countries and emerging markets	Often no standards for buildings Building standards often unsuitable Existing standards are not enforced

Figure 5.3: Reasons for non energy-efficient construction in developing countries and emerging markets

5.2 Analysis of the environmental impact

In the three technology sectors considered in this study it has been possible to **quantify** a large number of environmental effects The most important of these are summarised in the following table:

Case study	Environmental impact
1. The transfer of second-hand machinery and equipment	
The steel industry 3 million tonnes of used steel capacities per year additionally in China	After 10 years absolutely 280 million tonnes of CO_2 115 million tonnes more than in comparable plants in Germany
Refineries Used capacities of "100 million tonnes a year" one single time	90,000 tonnes of VOC, 90,000 tonnes of SO_2 5,600 tonnes of NO_x , 9,000 tonnes of CO in additional pollution per year vis-à-vis BAT
The generation of energy Every year fossil second-hand power stations with a capacity of 23.6 GW instead of fossil BAT	40 million tonnes of CO_2 per year in additional pollution vis-à vis BAT, i.e. 2.2 billion tonnes of CO_2 after 10 years
Cement Capacities of 8 million tonnes actually for sale	40 million kWh a year vis-à-vis modern technology (corresponds to 40,000 tonnes of CO_2 per year)
2. Transfer of second-hand vehicles	
Cars Export of 465,000 second-hand cars from Germany each year	Each year additional pollution of 240,000 tonnes of CO_2, 4,300 tonnes of nitrogen oxide and 1,300 tonnes of hydrogen carbons in comparison with new cars. An additional pollution of 13.2 million tonnes of CO_2 in 10 years
Export of 300,000 cars to Africa each year	Absolute pollution of 5,900 tonnes of nitrogen oxide 70,000 tonnes of carbon monoxide and 10,000 tonnes of hydrocarbons each year
Export of second-hand cars to developing countries and emerging markets world-wide (3 million units per year)	1.8 million tonnes of CO_2 each year, 100 million tonnes of CO_2 in 10 years
Trucks Export of 66,000 trucks from Germany to developing countries and emerging markets each year	Additional pollution of 5,700 tonnes of nitrogen oxide and 1,200 tonnes of hydrocarbons in comparison with trucks with the EURO 3 standard
3. Energy efficiency of buildings	
Philippines Through enforcement of the "National Code“ for new buildings	165,000 tonnes of CO_2 each year (9 million tonnes of CO_2 after 10 years)
Through enforcement of the "Guam Codes“ for new buildings	330,000 tonnes of CO_2 per year (18 million tonnes of CO_2 after 10 years)
China A 50 % reduction of the energy consumption of new buildings in the field of municipal dwellings and commercial premises with a 10 % increase in the costs of investment	15 million tonnes of CO_2 per year (800 million tonnes of CO_2 after 10 years)
Pakistan Improved insulation of the roof with realistic thermal transfer	1,040 GWh in savings by 2020

Figure 5.4: Summary overview of the environmental impact of various case studies in the target sectors of the study

It should be noted that the individual results **are only comparable to a limited extent**. The state of the data, the assumptions, the questions, the geographical focus and also the type of emissions are too diverse in the individual fields of technology.

However the general overview makes the general **scale of the environmental problems** apparent. In order to be able to better categorise the extent of the estimated emissions, it is recommendable to take a look at other studies that estimate the environmental impact of applications of technology and patterns of consumption. Taking the series of ALGAS studies, merely as an example, it can be seen that the additional emission of CO_2 in the various scenarios for the export of second-hand machinery and equipment is very high in view of the possible potential for savings in the same sectors using various measures to improve energy efficiency.

A comparison with the estimated total emissions of a country is also interesting. China emits some three billion tonnes of CO_2, India some one billion tonnes and Nigeria about 90 million tonnes. Thus the improvements mentioned for new dwellings and official premises in China, for example, would bring total savings in CO_2 emissions of about 3 per cent after ten years. The one-off transfer of fossil second-hand power stations on the specified scale to India would cause additional pollution of about 4 per cent in comparison with BAT. On the basis of the data available it does not seem possible to make any general statements regarding how far the export of second-hand machinery and equipment to the value of 100 billion US$ negatively impacts the environment. However in the case of second-hand vehicles it can be concluded that world-wide exports to the value of approx. 50 billion US$ will result in additional CO_2 pollution of roughly 1.8 million tonnes each year.

As important as it is to keep these figures in mind, in order to understand the significance of the problem, they provide only little information about the concrete effects of exports.

In order to judge the environmental impact of the export of a second-hand refinery it is necessary to know what the alternative would be. Would an old, existing refinery be continued to be operated instead of the second-hand refinery or would an entirely new one be built instead? Would the new refinery conform to western standards or be manufactured locally and only have very poor energy efficiency? Could the emissions of the second-hand refinery be substantially reduced and energy efficiency increased through minor conversion measures?

The comparatively detailed considerations in the field of the generation of energy lead one to suspect that the additional costs for more modern technology possibly represent a sensible investment as opposed to a second-hand solution as regards the protection of the climate. This could be supported by development banks or supplied within the framework of BOT projects.

In addition to the consideration of the country of import a full assessment of the situation must also take account of the consequences in the country of export. Would the technology cycle slow down if sales of second-hand equipment were less robust? Would the development of environmental standards be delayed? Would the purchase of a new plant with better emission readings be delayed or not carried out at all in the individual case?

The various variables can be very different in the individual case. Thus fundamental

statements concerning trade in second-hand machinery and equipment and in second-hand vehicles are difficult to make and are only possible subject to reservations. However some considerations concerning the advantages and disadvantages of trade in second-hand machinery and equipment and in second-hand vehicles are only possible in this very complex context.

The advantages of trade in second-hand machinery and equipment or in second-hand vehicles	**The disadvantages of trade in second-hand machinery and equipment or in second-hand vehicles**
Intensification of use and prolongation of lifetimes	The industrialised countries unload their environmental problems onto developing countries (disposal in developing countries and emerging markets)
Second-hand machinery and equipment or second-hand vehicles replace even poorer machinery, equipment or vehicles	Greater emissions than BAT
Limited absorption capacity for modern technologies in developing countries and emerging markets	The technological gap is growing
Older machinery is more labour-intensive and tends to be more suitable for low-wage countries	The long-term nature of the investment

Figure 5.5: The advantages and disadvantages of second-hand exports

In the individual case the import of older, second-hand technologies can be a realistic method of introducing environmentally friendly technologies to developing countries. While vehicles without catalytic converters are still produced in India, for example, imported vehicles are sometimes equipped with a catalytic converter (Panagariya, 2000).

There is also a chance that the import of second-hand machinery and equipment or of second-hand vehicles will gradually lead to the import of the underlying standards. These are sometimes higher than the applicable domestic standards in the countries of import.

Furthermore the advantages of the export of second-hand machinery and equipment and of second-hand vehicles include the intensification of use and the prolongation of lifetimes. In many cases the goods transferred can replace a capital stock which is an even greater polluter (**replacement investment**).

However in most cases the capital stock in the countries of import is not replaced, but new capacities are built up on the basis of second-hand machinery and equipment (which is no longer used in industrialised countries) (**expansion investment**). In some industrialised sectors this can be beneficial due to the lower absorption capacity in developing countries. In addition these machines are usually more labour intensive than new machinery and thus tend to be more suited to low-wage countries. From an economic and social point of view, exports frequently involve advantages.

From an ecological point of view, a critical view must be taken of expansion investments with second-hand machinery and equipment or second-hand vehicle. In environmentally intensive sectors there is **additional net pollution for the environment** in the long term in comparison with modern technologies. This study has succeeded in giving some indication of the "scale" of the negative impact on the environment. This will serve as an initial guide as to

the sectors in which second-hand exports must be seen as particularly critical.

In considering second-hand exports it is important to note that certain kinds of second-hand machinery and equipment can have similarly serious effects on the environment in the long term as the export of poisonous waste, insecticides or fertilisers. Second-hand exports should therefore have similar **significance in the public debate.**

It is a cause for concern that with rising **environmental standards** and "end-of-life-regulations“, such as the Old Car Regulations in industrialised countries, the tendency to export machinery, equipment and vehicles to developing countries and emerging markets could even increase if no reasonable restraints are imposed.

In addition to this, second-hand exports can have yet another disadvantage, one that is often underestimated. Navaretti proves that developing countries buy machinery that is all the older, the greater the technological progress in a machinery segment is. He thus emphasises the danger of **the failure to keep up with technological progress** or of widening the technological gap. In 2020 developing countries will account for some 42 per cent of the world's energy consumption. (In 1995 this was only around 33% and in 1975 as low as 15%). It therefore becomes clear that this failure to keep up can have dramatic consequences for humankind and nature. Additional measures that alleviate the environmental impact of the export of second-hand goods could result in a marked improvement here.

Finally the substantial environmental impact of non energy-efficient construction in developing countries and emerging markets is something that is not even separately discussed. It is nevertheless obvious. Here, perhaps even more than in the case of second-hand machinery and second-hand vehicles, the long-term nature of the investments is causing a problem of immense proportions to build up. When the problem has finally become acute it will hardly be possible to put matters right.

5.3 Hypotheses

Although a series of questions could not be finally clarified by the project, a number of indicators have been compiled that allow the formulation of numerous fundamental hypotheses. These hypotheses can only be verified through further investigations. However, as these hypotheses are of importance for the future actions of political and private parties they are briefly summarised here.

1. The transfer of second-hand machinery and equipment is currently undergoing a fundamental revolution.

At present the transfer of second-hand machinery and equipment is developing from a niche market to become an important sector of the economy. This has been triggered and enabled by the internet. The decisive advantage of second-hand machinery and equipment vis-à-vis new products lies in their lower costs and their more rapid availability. In the past these two benefits could not be enjoyed to the full as there was too much confusion in the market . The search for suitable offers was very time-consuming and expensive, which vastly curtailed the

advantages of second-hand machinery and equipment. Now, using the internet, it is possible to deal in second-hand machinery and equipment very much more quickly and at lower transaction costs.

2. The transfer of second-hand machinery and equipment is becoming a phenomenon that transcends different branches of industry

The decisive factors of market growth as regards the transfer of second-hand machinery and equipment are not specific to sectors. It can therefore be expected that the transfer of second-hand machinery and equipment will not only experience a considerable boom in the areas covered by the study, but in all sectors of industry. This boom will be linked with the usual developments in new branches of industry: standardisation and the creation of norms, the appearance of special service providers etc.

3. There is a political and administrative *time gap* in the case of exports of second-hand machinery and equipment.

Politicians and the administration are not prepared for the rapid growth in the transfer of second-hand machinery and equipment, neither in Germany nor in most of the other countries throughout the world. As this market has so far been of subordinate importance it was not necessary to keep an eye on it. At present the statistical data that should form the basis for all further steps is not even available. Nor has there yet been any political discussion of the consequences of trade in second-hand machinery and equipment. At present trade in second-hand machinery and equipment is, to some extent, moving in a political and administrative vacuum.

4. The political world does not take sufficient account of the environmental impact of the export of second-hand machinery and equipment

Second-hand machinery and equipment requires particular intensive vigilance. This is demanded by the very nature of the matter. The machinery and equipment satisfy only outdated standards. They have also been subject to wear and tear and therefore usually have higher emission readings. At the same time buyers of second-hand machinery and equipment usually have only few capital resources. For this reason they will hardly be inclined to carry out upgrading measures of their own free will to reduce the polluting effects. While the need for political control mechanisms to protect the environment is great, in practice only few such mechanisms exist. For the exporting countries the export of second-hand machinery and equipment is attractive in many ways. In addition to commercial advantages they promise to be an easy and unproblematic way of cutting down on pollution. The countries of import, for their part, often do not have the political and administrative capacities to introduce and implement effective legislation for the transfer of second-hand machinery and equipment.

5. Notwithstanding the complexity of the interrelated effects, it is possible to make some rough estimations as to the environmental impact of the export of second-hand machinery and equipment.

An assessment of the import of second-hand machinery and equipment is quite complex in the individual case. Account should be taken of the effects in the country of origin and also of

the effects in the country of import. There a used plant can replace old and less efficient plants or cause further pollution as an additional plant. It should also be considered what the alternative to the import of second-hand machinery and equipment is. This alternative does not necessarily mean a new plant with lower emissions. Despite these problems in the individual case it is nevertheless possible to make some rough estimations in general for the evaluation of the environmental impact of the transfer of second-hand machinery and equipment. Thus comparisons between import and production can be revealing. It is also possible to develop various baseline scenarios which assist in the basic evaluation of the imports.

6. In the case of exports of second-hand machinery and equipment there is a lack of incentive to reduce environmental pollution

The export of second-hand machinery and equipment allows its owners to disregard environmental standards. If tougher environmental standards have been introduced and plants may no longer be operated or the costs of upgrading are too high, export represents a profitable alternative. For buyers of second-hand machinery and equipment it is difficult to evaluate its consumption of energy and resources as there is no standardised data. It is therefore only logical that buying decisions tend to be based on the costs of investment rather than on the running costs. Solutions that are more economical in the long term and more efficient in terms of environmental impact and energy (new plants) are not therefore given any consideration.

7. Increasing exports of second-hand machinery and equipment undermine efforts to reduce greenhouse gases

The transfer of second-hand machinery and equipment must be seen critically in view of the international efforts to reduce the emission of greenhouse gases. In view of further market growth and the cumulative effects (the imported second-hand plants being used for many years) and also considering that these are usually expansion investments, it can be seen that an environmental problem is developing which has so far been ignored.

8. Approaches have been made to limit the environmental impact of the export of second-hand machinery and equipment, especially in the case of the costs of investment

As one of the main reasons for the purchase of second-hand machinery and equipment is the possible savings in the capital outlay and the insufficient capital resources of the buyers, development banks, export credit institutes as well as operator models can be used in a meaningful way to specifically avoid exports that give cause for concern as regards their environmental impact.

9. Further approaches to limit the environmental impact of the export of second-hand machinery and equipment are to be found in import policies and the establishment of best practices.

There is as yet no exchange of notes as regards import policies. Consultation on import policies could ultimately lead to the establishment of international best practices in the transfer of second-hand machinery and equipment. This, in its turn, could provide orientation for the countries of export.

10. Second-hand exports will also become more important in the field of consumer goods

In contrast to the market for investment goods, the internet does not have so much relevance for the transfer of consumer goods. What is important, rather, is the constant pressure from the legislature ("end-of-life legislation“). More and more branches of industry are being forced to introduce systems for the return of goods. The collection of old equipment and appliances will form the decisive basis for the export of second-hand goods. On the whole trade in second-hand consumer goods, however, will not achieve the same significance as in the case of investment goods. The export of second-hand consumer goods remains limited to certain goods which tend to be in the higher price category. This, after all, affects only a few sectors.

11. So far the global effects of "end-of-life legislation“ have not been given sufficient consideration

While the European Union is increasingly producing legislation for individual sectors of industry, there is still relative ignorance concerning the extent to which this legislation relocates pollution. It is possible that the longer lifetimes of exported second-hand consumer goods and their improper disposal will trigger additional environmental problems of monumental proportions. This is apparent in the field of second-hand vehicles where the increasing exports are causing heavy pollution to be exported at the same time.

12. Exports of second-hand vehicles are creating a legislation paradox

As is the case with investment goods, the export of second-hand vehicles is causing a paradoxical situation. Current legislation for the protection of the environment is most potent where it is least needed. Thus cars are regularly checked for their exhaust gases in the first years of use. Later, however, when there is a high risk of these emission readings deteriorating, the exported vehicles are no longer subjected to any further checks. The structure of control instances and the conception of disposal policies is therefore critical in the countries of destination for the export of second-hand vehicles.

13. The lack of energy efficiency in buildings is of supreme importance from the point of view of climate policy

Maladjusted concepts for buildings are still the rule rather than the exception in developing countries and emerging markets, even in the case of new buildings. Population growth and urbanisation are exacerbating the situation. The long life cycles of buildings also make a preventative policy particularly important in this area. So far, however, there have been relatively few efforts to achieve adjusted, energy-efficient concepts.

14. The chances for energy efficiency measures are particularly high in the case of buildings in developing countries and emerging markets

Energy saving measures for new buildings or when renovating old buildings often not only cover the costs, but are clearly profitable. As there is a lack of the necessary investment capital, on the one hand, and the necessary role models on the other, large-scale CDM projects would be a meaningful option.

6 Outlook

In view of today's global environmental problems it would be desirable for developing countries and economies in transition to catch up in terms of industrial development. This is a process that is characterised by the transfer of the highest ecological standards for production techniques and products. The full enforceability of this requirement, however seems unrealistic in view of the costs it involves. The resistance of the developing countries is not fully incomprehensible, even against the background of sustainability. They initially prefer partial goals such as increasing gross domestic product, the rate of employment and the rate of investment, all to the detriment of the environment.

As the "best available technology“ is usually at the same time the “**most expensive available technology**”, there often remain, as a second-best solution, only second-hand technologies and equipment. In as far as import policies allow, entrepreneurs from developing countries have long reacted and are searching world-wide for second-hand machinery and equipment which it is profitable to purchase under the specific conditions of their countries of origin or which is worthwhile in another form.

The transfer of second-hand machinery and equipment from the industrialised countries to developing countries and emerging markets is therefore an **everyday reality** whose quality and quantity has been partially exposed in the context of this study. Every year second-hand machinery and equipment with a value of more than **100 billion US$** is sold throughout the world. This figure is probably substantially higher if we consider that second-hand machinery and equipment is also used within the framework of foreign investments. It has been shown that second-hand machinery and equipment with sometimes double-digit rates of growth are also sold in developing countries and emerging markets and there often account for a large proportion of all imports of machinery. On top of this come second-hand cars and trucks to the value of **50 billion US$.**

In view of the environmental impact of these exports it is interesting to note that the total value of the exports is not decisive at all. The prices merely reflect **"residual values"** and it can be suspected that old and polluting second-hand machinery and equipment has almost no more value at all.

However: If we assume a 50 per cent saving in the costs of investment on the purchase of second-hand machinery and equipment and second-hand vehicles, the theoretical new value of second hand exports can be calculated at approx. 300 billion US$, an amount which, corresponds to the volume of environmental technology sold each year throughout the world according to the OECD.

This comparison should finally make it clear that the second-hand goods transferred represent an **independent branch of industry**, something which hitherto only been recognised by the companies involved in the trade. This study has cast light on the method of functioning, the problems and the particular features of this branch of industry.

It has also become apparent in the study that trade in second-hand goods and equipment and in second-hand vehicles increasingly brings environmental problems in its wake and on

a considerable scale. Regardless of the fact that trade in second-hand machinery and equipment and in second-hand vehicles cannot be evaluated as polluting or ecological on the basis of a simple model, the net environmental impact of the second-hand goods exported is very high. A further exacerbating factor is the long-term nature of the investments. It is therefore time to think about approaches for alleviating the pollution caused by the goods and to identify where these approaches exist.

Without doubt it was neither the task nor the aim of this study to offer the appropriate proposals for action. However in conclusion it will be sketched out in keywords how a meaningful approach to the subject could be taken by identifying a number of potential starting points. From the very outset it should be remembered that uniform solutions for various sectors and countries are not possible due to the heterogeneity of the subject matter. Furthermore it should be considered that the solution to the growing environmental impact of trade in second-hand machinery and equipment and in second-hand vehicles cannot be left solely in the hands of the governments of developing countries and emerging markets. In view of the immensity of the problems and their effects, inter alia, on global phenomena such as the greenhouse effect, the exporting countries, i.e. the industrialised countries as a rule, also need to confront this problem.

There are a large number of potential approaches. Some of them are mentioned here as an example. This is merely a selection and does not imply any evaluation of the prospects for success or the quality of such approaches:

- optimisation of the assistance given by export credit institutes,
- the introduction of benchmarking systems[6],
- the introduction of minimum standards for certain exports of second-hand goods,
- linking trade in second-hand goods to activities in the CDM field,
- taking up the subject in the context of the guiding principles of the OECD for multinational companies,
- the creation of independent guidelines for manufacturers and dealers of second-hand machinery and equipment,
- the introduction of a labelling system,
- the promotion of ecological maintenance and modernisation measures on the transfer of second-hand goods,
- encouraging the countries of import to exchange notes in order to develop suitable import policies,
- contracting as a solution to the lack of financial resources.
- …

Independently of concrete measures it first seems necessary to make the problem of the export of second-hand machinery and equipment and of second-hand vehicles a subject for

6 Such as in the style of Bosis "An Initial View on Methodologies for Emission Baselines: Electricity Generation Case Study":

discussion in the informed public circles and to initiate a political debate on the matter.

For the further debate on the subject it should be considered that many questions are still open. Even the dimension of the problem is slowly becoming apparent. Many detailed questions on both the causes and the effects of trade in second-hand machinery and equipment and in second-hand vehicles and also the possible opportunities for influencing environmental policy are still unclear.

- There is currently a great deal of uncertainty concerning the scope of second-hand machinery and equipment within the framework of foreign investments. In the course of globalisation and local economic growth owners of second-hand machinery and equipment are without doubt using this in order to expand into new markets. The precise significance of second-hand machinery and equipment for foreign investments, however, could not be quantified in this study. However it is likely that there is a very important grey area here.

- Only little is known regarding the environmental aspects, effects and motivations behind import policies in respect of second-hand machinery and equipment and second-hand vehicles. The present study has been able to cast some light on various approaches, but much remains in the dark. A virtually unknown factor is the success of various import policies, particularly in relation to the environment.

- A topical question that has yet to be answered is certainly the extent to which the negotiations within the framework of WTO and GATTS are having an effect on trade in second-hand machinery and equipment and, in particular, the extent to which they are impacting the environment. The restrictions on non-tariff trade obstacles within the framework of the negotiations can put a marked restraint on potential ecological controls of trade in second-hand machinery and equipment and in second-hand vehicles and at the same time lead cause this market to expand even further.

- The question of the consequences of the Old Car Regulations for German exports of second-hand vehicles was intended as an example. At the same time, however, it is symptomatic of the breadth and the depth of the subject as a whole. Here too the information currently available is insufficient although the question is of evident importance for a meaningful evaluation of the Old Car Regulations.

Like the list of possible political and legal options for action set out above, this short list does not raise the claim to have addressed all or even the most important questions for research. These questions, rather, are intended to highlight the gap between the status of academic knowledge and the ecological significance of the problem.

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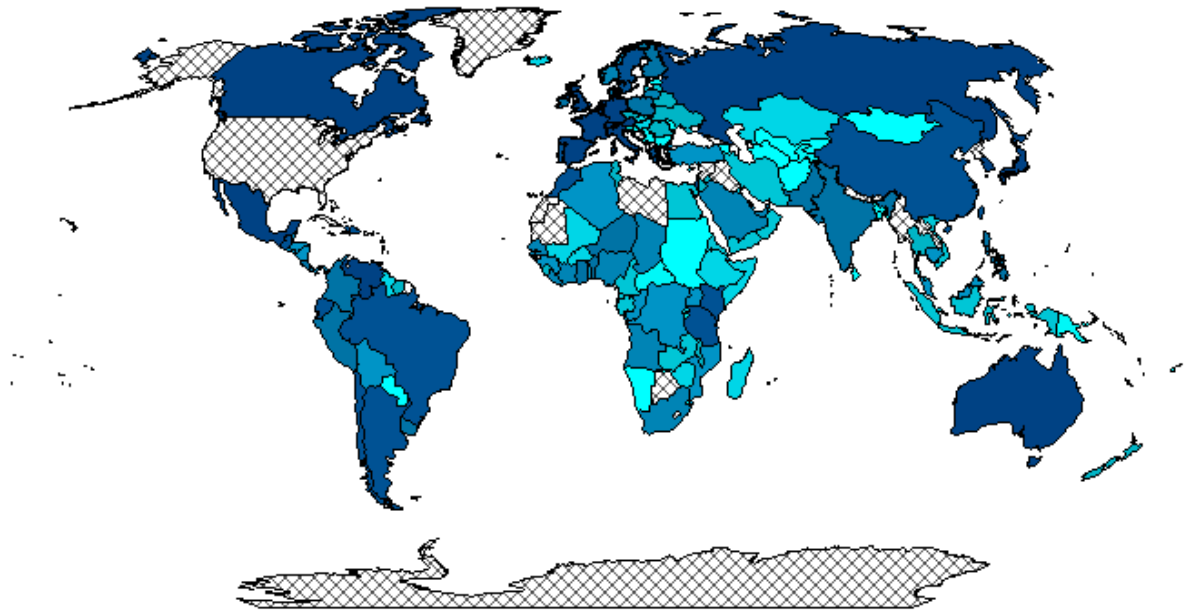
8 Annex

Annex 1.1: North American Industry Classification System, Used Merchandise, source: US Department of Commerce



2001 Used Merchandise from UNITED STATES
(in thousands)

$25,004	to	$1,102,620	(18)
$8,213	to	$25,004	(17)
$3,929	to	$8,213	(17)
$2,400	to	$3,929	(17)
$1,431	to	$2,400	(17)
$720	to	$1,431	(15)
$292	to	$720	(18)
$100	to	$292	(18)
$26	to	$100	(18)
$3	to	$26	(18)

Annex 2.1 : Energy-intensive industrial sectors in India – source: UNEP

Table 2
Energy-intensive industrial sectors in India

Project category	Emissions mitigation opportunity	Size of opportunity	Overall investment potential	Energy benefits expected	Carbon reductions expected
Electricity generation					
Coal washing	Reduction of ash content from 40 to 30%	5000-6000 MW of capacity	$1.8 billion	5500 Btu/kg coal	11 million metric tonnes/year
Fuel switching	LNG importing in current coastal coal plants	3800 MW	$3.1 billion	0.15 kg carbon/ kWh	4 million metric tonnes/year
Conventional efficiency	1.5% improvement of thermal efficiency	6500 MW	$0.15 billion	Not available	4 million metric tonnes/year
IGCC power	Installation of IGCC technologies	10,000 MW	$10 billion	2000 Btu/kWh	5 million metric tonnes/year
Renewables	Wind, solar, bagasse and mini hydro	35,000 MW	$25 billion	0.35 kg carbon/kWh	60 million metric tonnes/year
Industrial sector					
Caustic soda	Conversion of mercury cell process to membrane cell	900,000 metric tonnes of capacity	$8.4 billion	500 kWh/ metric tonne produced	120,000 metric tonnes/year
Cement	Upgrading from wet to dry process	45,000,000 tonnes of capacity	$4 billion	90 kWh/metric tonne produced	1.1 million metric tonnes/year
Aluminium	Upgrading to Hall-Herault process	Balco and Indal plants	$8.4 billion	1500 kWh/ metric tonne produced	Not available
Steel	Updating of open hearth process plants	Not available	$4.3 billion	2.8 Mmbtu/ tonne of clinker	0.8 million metric tonnes/year

Source: Haigler Bailly, Climate Change Handbook

Annex 2.2: Used refinery capacities transferred or yet to be transferred by Chemex (in thousand BPD) - source: www.chemexinc.com

Year	Size (TBPD)	Origin	Destination
1987	30	California	not known
1998	30	California	not known
1990	25	California	not known
1991	5	Wyoming	not known
1992	2	Texas	Africa
1993	3	Dakota	USA
1993	30	California	Middle East
1994	60	California	Asia
1994	22	Ohio	Far East
1995	125	Mannheim (BASF)	Asia
1995	10	Texas	Africa
1995	5	Texas	Not yet sold
1995	4	Los Angeles	Russia
1995	100	Europe	probably Asia
1996	10	not known	Africa
1997	5	not known	CIS
1997	2	not known	Georgia
1997	2	not known	CIS
1997	5	Alabama	not known
1997	1,5	not known	Africa
1998	6	not known	Dagestan
1998	4	not known	Georgia
1999	2	not known	Russia
2000	25	not known	Nigeria
2001	20	not known	Thailand
2001	6	Canada	not known
2002	8	not known	Bulgaria
	547,5		

Annex 2.3: Scale effects in the German cement industry

Table: **Economies of Scale in the German Cement Industry**

Plants with a production of	1963		1974		1982		1991		1996	
	no.	%	no.	%	no.	%	no.	%	No.	%
0 - 200.000t	44	45	23	23	25	34	22	8	18	7
201- 500.000t	35	36	35	35	42	36	17	19	25	27
501- 1.000.000t	16	17	17	17	20	22	24	59	17	41
over 1.000.000t	2	2	2	8	10	8	3	14	6	25
	97		83		74		66		66	

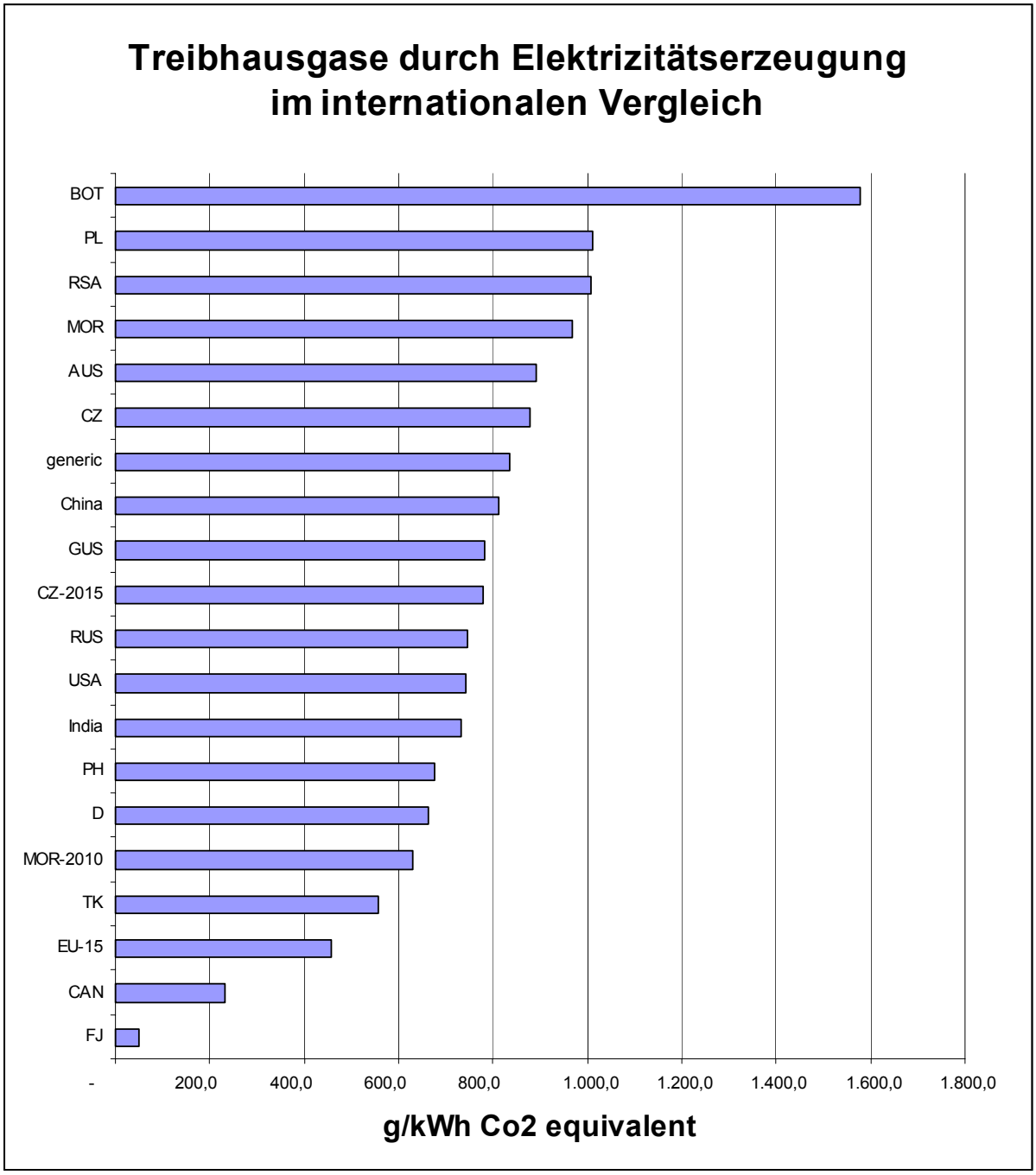
Source: Zement, Zahlen und Daten, different years

Annex 2.4: National Baselines Based on Recent Capacity Additions (after 1994) and those Currently Under construction in India, source: OECD - An Initial View on Methodologies for Emission Baselines

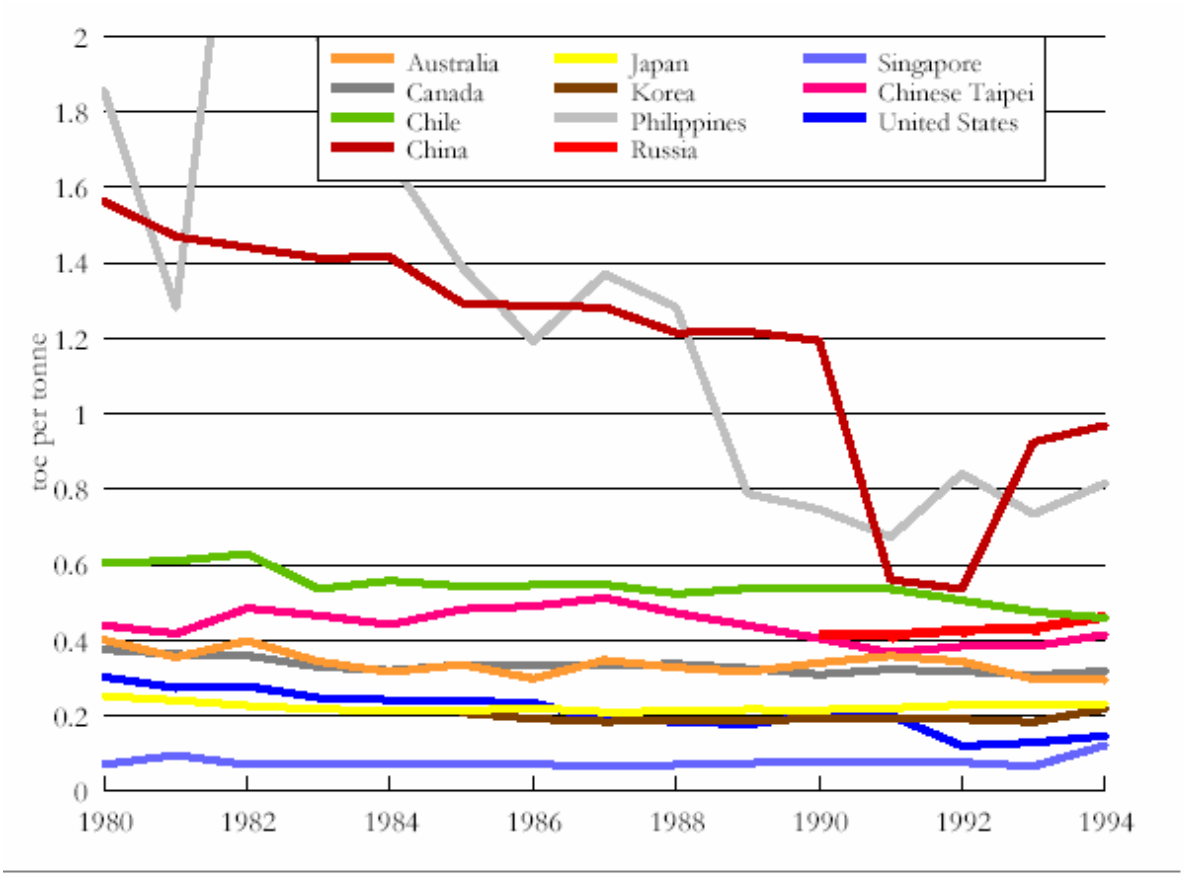
Electricity Source	Number of Plants	Total Capacity (MW)	Electricity Output (GWh)	Percentage of Total Electricity Output	GHG Emissions (tCO2/GWh) *weighted average*
All sources	617	35770.27	168,710.02	100%	**565.43**
Fossil fuel only	273	17285.99	99,352.02	58.9%	**960.15**
Nuclear	7	2,160.00	8,614.51	5.1%	**0.00**
Waste heat	14	1,475.20	9,592.49	5.7%	**0.00**
Biomass	2	48.68	295.44	0.2%	**0.00**
Hydro	190	14,437.28	50,068.50	29.7%	**0.00**
Natural Gas	35	1,773.50	10,493.17	6.2%	**417.80**
Oil	170	2,989.69	12,841.50	7.6%	**661.41**
Coal	68	12,522.80	76,017.35	45.1%	**1,085.48**
Wind	131	363.12	787.06	0.5%	**0.00**

N.B. OIL includes diesel oil, heavy fuel oil, distillate oil, and naphtha; COAL includes bituminous coal, sub-bituminous coal, lignite, coke-oven-gas, blast furnace gas, and coal gas from coal gasification; BIOMASS includes bagasse.

Annex 2.5: Greenhouse gases produced through the generation of electricity on an international comparison, source: GEMIS 4.1



Annex 2.6: Development of the energy intensity of the steel industry of various APEC countries, source: Asia Pacific Energy Research Center, 2000



Annex 3.1: Average emissions of the new vehicle fleet according to countries and type of fuel, source: European Automobile Manufacturers Association and the Commission Services, "Monitoring of ACEA's Commitment on CO_2 Emission Reduction from Passenger Cars (2001) - Final Report", 25 June 2002

A1. SPECIFIC FUEL EFFICIENCY (L/100) AND EMISSIONS OF CO2 (g/km)
AVERAGED OVER ALL NEWLY REGISTERED PASSENGER CARS FOR EACH DIFFERENT FUEL-TYPE, FOR THE EU AND EACH MEMBER STATE

2001 – ACEA MEMBERS

Member State	Total	identified version										unknown version
		Petrol			Diesel			Petrol + Diesel			Other	
	Number	Number	average Fuel	average CO2	Number	average Fuel	average CO2	Number	average Fuel	average CO2	Number	Number
EU-15	**12,552,498**	**7,307,284**	**7.3**	**172**	**4,941,638**	**5.8**	**153**	**12,248,922**	**6.7**	**164**	**18,080**	**285,496**
A	247,898	75,803	7.1	169	171,654	5.7	152	247,457	6.1	157	10	431
B	432,309	143,240	7.1	169	288,895	5.7	151	432,135	6.2	157	48	126
DK	74,646	58,476	7.6	180	16,004	5.6	148	74,480	7.2	173	3	163
F	2,114,015	902,772	7.0	164	1,208,256	5.7	150	2,111,028	6.2	156	2,986	1
FIN	82,028	65,687	7.8	184	15,302	6.0	160	80,989	7.4	179	6	1,033
GER	2,963,088	1,808,014	7.6	181	1,063,605	6.0	159	2,871,619	7.0	173	468	91,001
GR	186,635											186,635
IRE	112,552	94,329	7.0	166	17,109	6.0	158	111,438	6.9	165	1	1,113
IT	2,110,599	1,277,363	6.5	154	819,334	5.7	151	2,096,697	6.2	153	12,927	975
LUX	38,570	15,182	7.8	186	23,361	5.9	155	38,543	6.6	167		27
NL	427,820	312,152	7.5	177	114,449	5.8	155	426,601	7.0	171	121	1,098
P	221,587	153,600	6.6	156	67,977	5.7	150	221,577	6.3	154	4	6
SP	1,287,068	573,367	7.2	169	712,196	5.6	148	1,285,563	6.3	157		1,505
SW	204,521	191,109	8.5	201	12,758	6.5	173	203,867	8.4	199	12	642
UK	2,049,162	1,636,190	7.5	178	410,738	5.9	158	2,046,928	7.2	174	1,494	740

Annex 3.2: Development of average CO_2 emissions, source: European Automobile Manufacturers Association and the Commission Services, "Monitoring of ACEA's Commitment on CO_2 Emission Reduction from Passenger Cars (2001) - Final Report", 25 June 2002

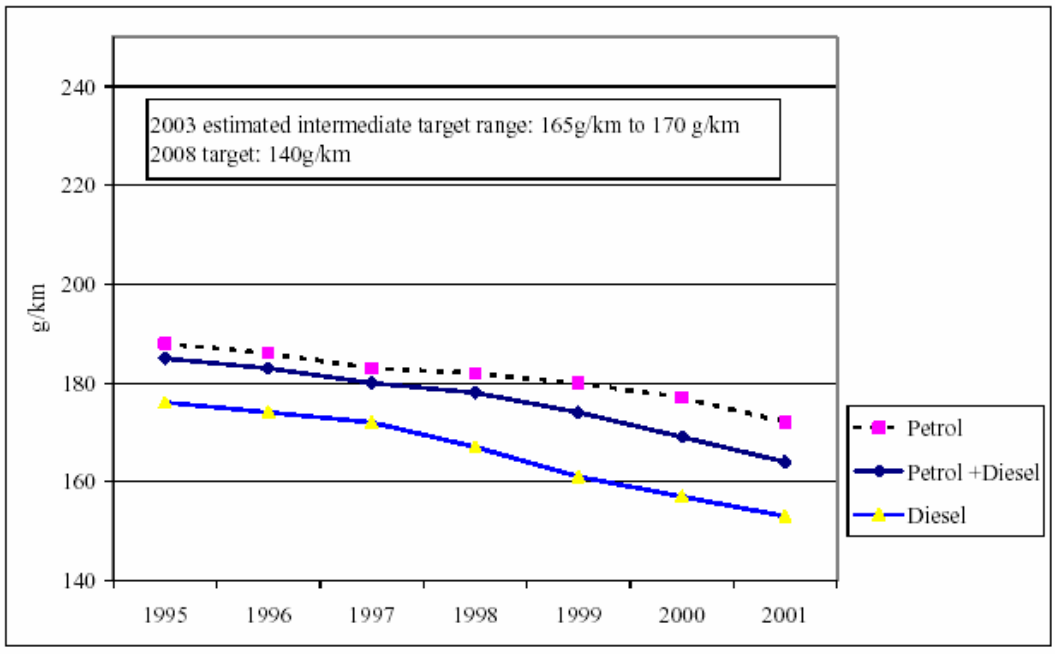
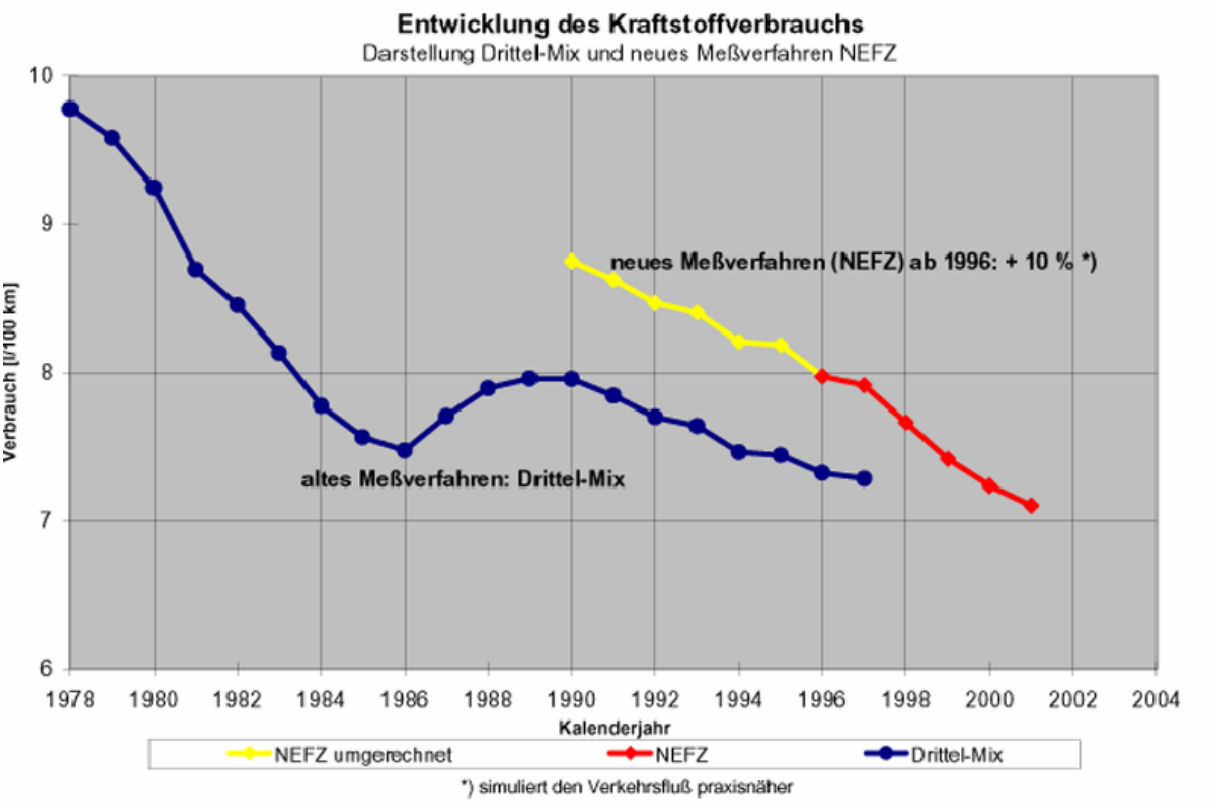


Figure 1: EU Trends of ACEA's Fleet in Specific Average Emissions of CO_2

Annex 3.3: Development of fuel consumption, source: VDA



Annex 4.1: Calculation of the OTTV for the basis building or alternatives in conformity with the guidelines - source: “Energy efficiency policy and technology transfer: A Hawaii-Philippines Case Study”

The equation for OTTV accounts for the

- U-factor of the opaque portion of the wall (Uw),
- the solar absorptance of the opaque wall (A),
- the U-factor of the window or glass (Ug),
- the shading coefficient5 of the glass (SC),
- windowwall ratio (WWR),
- Wall orientation taken into account through the solar factor (SF).

Table 5.2 OTTV Calculations for the Base Case Building

Bldg. type	Orientation	WWR	SC	Uw	Ug	Abs	OTTV
Office	North	0.49	0.88	1.22	4.59	0.65	333
Office	South	0.49	0.88	1.22	4.59	0.65	542
Office	East	0.49	0.88	1.22	4.59	0.65	663
Office	West	0.49	0.88	1.22	4.59	0.65	576
						Weighted Average	559

Table 5.3 OTTV Calculations for a Code Complying Building

Compliance Option 1 (Double Tint SS14)

BldgType	Orient	WWR	SC	Uw	Ug	Abs	OTTV
Office	North	0.42	0.18	1.22	2.35	0.65	31
Office	South	0.42	0.18	1.22	2.35	0.65	47
Office	East	0.42	0.18	1.22	2.35	0.65	56
Office	West	0.42	0.18	1.22	2.35	0.65	50
					Weighted Average		48

Compliance Option 2 (Single Clear SS08)

BldgType	Orient	WWR	SC	Uw	Ug	Abs	OTTV
Office	North	0.25	0.23	1.22	4.90	0.65	31
Office	South	0.25	0.23	1.22	4.90	0.65	46
Office	East	0.25	0.23	1.22	4.90	0.65	55
Office	West	0.25	0.23	1.22	4.90	0.65	49
					Weighted Average		48

Annex 4.2: Building activities in the Philippines, source: “Energy efficiency policy and technology transfer: A Hawaii-Philippines Case Study”

Appendix C: Construction Activity

The following tables show nonresidential construction volumes for the four period from 1993 through 1996 for the Philippines as a whole.

Table C.1 Nonresidential Building Construction Classifications and Categories

	Size			Typical Floors		
	Small	Medium	Large	Small	Medium	Large
Office	<1000 m^2	<5000 m^2	>=5000 m^2	1-3	4-10	11 +
Retail	<1000 m^2	<5000 m^2	>=5000 m^2	1	2-3	4 +
Hotel	<30 rooms	<100 rooms	>=100 rooms	1-3	4-10	11 +
Apartments	<10 rooms	<100 rooms	>=100 rooms	1-3	4-7	8 +
Other	<1000 m^2	<5000 m^2	>=5000 m^2	1-3	4-10	11 +

Table C.2 Average Annual Nonresidential Construction, Philippines, 1993–1996

	Small	Medium	Large	Total[1]	Percent
Square Meters					
Office	1,144,897	477,903	286,212	1,908,011	40%
Retail	511,697	146,173	73,067	730,897	15%
Hotel	79,638	24,504	18,378	122,520	3%
Apartments	987,436	185,144	61,715	1,234,295	26%
Other	558,061	111,612	74,408	744,082	16%
				4,739,774	100%
Number of Buildings					
Office	688	287	172	1,147	15%
Retail	1,195	341	171	1,707	23%
Hotel	60	18	14	92	1%
Apartments	2,439	457	153	3,049	41%
Other	1,123	247	150	1,520	20%
				7,514	100%

[1] *Totals may not sum due to rounding.*

Table C.3 Average Annual Nonresidential Construction, MERALCO, 1993–1996

	Small	Medium	Large	Total[1]	Percent
Square Meters					
Office	879,761	396,151	219,690	1,464,602	53%
Retail	231,609	66,174	33,087	330,870	12%
Hotel	22,146	6,814	5,111	34,071	1%
Apartments	476,059	89,606	29,679	397,373	22%
Other	243,906	48,768	32,512	325,186	12%
				2,752,305	100%
Number of Buildings					
Office	245	102	61	408	19%
Retail	196	57	28	282	13%
Hotel	10	3	2	15	1%
Apartments	849	159	53	1,061	50%
Other	268	54	36	357	17%
				2,123	100%

[1] *Totals may not sum due to rounding.*

Annex 4.3: Feasibility studies for improvements to the shell of commercial buildings in Pakistan, source: Algas

Roof Insulation (Roof Area: 5,000 sq. ft)

Cost without Mitigation: Rs. 0
Cost with Mitigation: Rs. 240,000
Annual Energy Saving: 4,388 kWh (savings up to 45% achievable)
Fuel Saved: Electricity

Incremental Cash Flow Statement

Year	*0*	*1st*	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*	*8th*	*9th*	*10th*
Investment	–240,000										
Saving in Energy Bill		25,535	28,580	31,977	35,767	39,678	44,013	48,819	54,145	60,047	67,095
Net Cash Flow	**–240,000**	**25,535**	**28,580**	**31,977**	**35,767**	**39,678**	**44,013**	**48,819**	**54,145**	**60,047**	**67,095**

Financial Analysis
NPV @ 20% discount rate: Rs. –6,219
IFRR: 19%
Payback period: 6.7 years

Annex 4.4: Feasibility studies for improvements to the shell of dwellings in Pakistan, source: Algas

Exhibit A.15: Improvements in Building Design—Residential Establishments

Roof Insulation (Roof Area: 2,000 sq. ft)

Cost without Mitigation: Rs. 0
Cost with Mitigation: Rs.100, 000
Annual Energy Saving: 1,890 kWh
Fuel Saved: Electricity

Incremental Cash Flow Statement

Year	*0*	*1st*	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*	*8th*	*9th*
Investment	–100,000									
Saving in Energy Bill		11,000	12,311	13,775	15,407	17,092	18,960	21,030	23,324	25,866
Net Cash Flow	**–100,000**	**11,000**	**12,311**	**13,775**	**15,407**	**17,092**	**18,960**	**21,030**	**23,324**	**25,866**

Financial Analysis
NPV @ 15% discount rate: Rs. 37,169
IFRR: 20%
Payback period: 6.5 years