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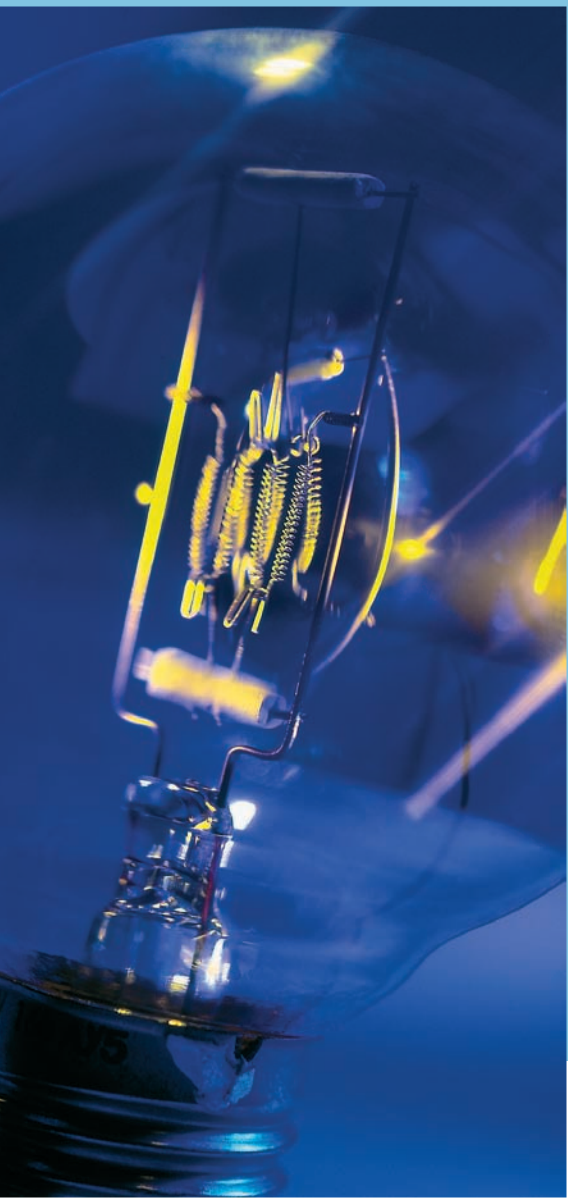


Energy Efficiency in Production

Future Action Fields

Fraunhofer Gesellschaft

Content

Efficiency signifies the relationship between the result achieved and the resources employed. (ISO 9000:2000)

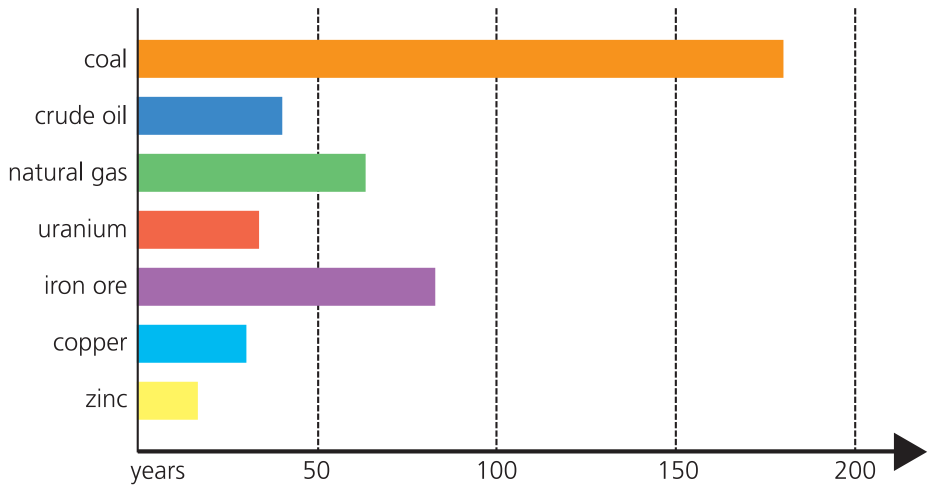
The 21st century is taking humanity to its natural limits. Whilst the earth's population is growing, the availability of raw materials such as oil, natural gas, mineral ores and water are declining, not only for the industrialised societies but also for third world and developing countries. The consumption-oriented behaviour in fast-developing countries such as China or India, imitating that in the affluent nations, requires a massive increase in gross national product throughout the world. At the same time, it is important to make a significant reduction in CO2 emissions to counteract further climate change.

The global demand for raw materials has risen greatly in recent times, and raw materials are becoming increasingly scarce and more expensive, - by more than 70 % overall between 2001 and 2008. Raw material costs as a proportion of total manufacturing costs, at between 30 and 80 %, are often much higher than labour as a cost factor.
The need for even more efficient utilisation of resources is coming more and more sharply into focus in business, in research and in politics. A crucial question is what options do companies have in the producing industries to reduce not only costs but also the use of resources and emissions, by exploiting more efficient technologies.

As part of a study sponsored by the Federal German Ministry of Education and Research (BMBF) in its outline programme "Research for the production of tomorrow" (Funding Reference No.: 02PU1000), the Fraunhofer Institutes and other research institutions analysed the potential for the saving of resources, especially energy, in the producing industries, and have derived from that the need for action in production research.

The institutes participating in the study are grateful to all sponsors and supporters, especially the BMBF, the Karlsruhe Research Centre in its capacity as the project management body and the Fraunhofer Gesellschaft.

Prof. Reimund Neugebauer



End of natural resources; Source: Bundesanstalt für Geowissenschaften und Rohstoffe 2000

The overall economic standing of a site is determined primarily by the added value achieved there. In Europe, a turnover of 1,500 billion Euros is achieved annually in manufacturing. This symbolically interprets 34 million employees are contributing in these sectors, and that, in turn, corresponds to 30 % of all jobs. Production is, above all, tied directly to natural resources and is directly affected by any shortage in these resources.

The consequence of this dependence – and taking into consideration the growing competition from developing countries – is the need to reduce the quantity of resources used whilst increasing production output, and therefore to improve the productivity of resources. This means manufacturing as much as possible from the use of a given quantity of raw materials and energy. A paradigm change is needed to achieve this:

Instead of "maximum profit from the minimum of capital" we need to achieve "maximum profit from the minimum of resources".

Whatever waste or heat there is in a process must be exploited rationally in a different manufacturing process. The challenge lies, as ever, in decoupling the consumption of resources from economic growth.

The specific final energy consumption in manufacturing industries in Germany was reduced by 64 % between 1960 and 2000.

Prerequisites for these increases in resource efficiency were and still are technological innovations and long-term investment.

Companies that are acquiring a cost advantage today through efficiency technologies will further consolidate this advantage disproportionately in the future. Equally, a clear and internationally harmonised political framework is necessary, because the required dramatic increase in resource efficiency is achievable only by uniting political and statutory requirements, incentives and stimuli.

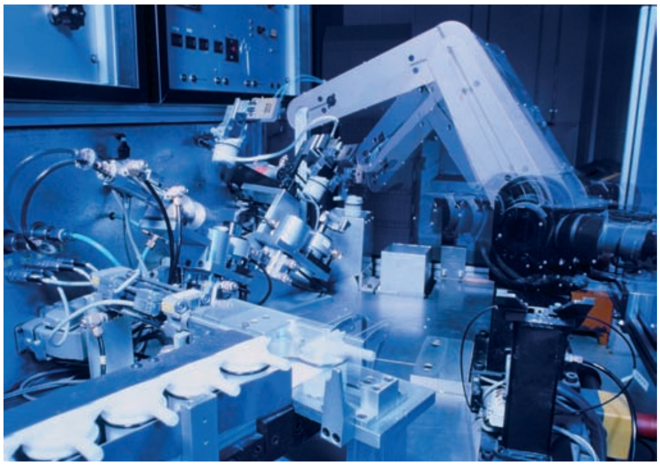
A poll of approx. 450 decision-makers and experts from companies, research institutions and industrial associations, conducted in the course of the study, shows that energy costs usually play a significant role so far in investment decisions. Payback periods of one to three years are expected for investments in efficiency. But resource-intensive process steps can only be optimised in such short lengths of time; they cannot be replaced or, indeed, eliminated.

Only one third of the companies questioned during the study have outline plans for the systematic evaluation of resource efficiency and for the optimisation of production processes.

The dynamics of price trends for raw materials and energy in recent years will tend to continue. Global problems such as the general competition for resources, limits on emissions imposed by law and demographic effects will determine the basic parameters as far as company business is concerned even more markedly in future. What possibilities can be deduced from this for the processing industries in Germany?

In industrial production as a whole, energy savings of 25 to 30 % are possible in the medium term. An energy saving potential of approx. 210 petajoules per annum was identified simply for the product classes considered in the study, and this is equivalent to about half the electricity consumption by private households in Germany, or four power stations each with an output of 1.4 gigawatts.

Production engineering is one of the most important branches of industry in Germany. However, an increase in productivity, which occupies a key position in the struggle for competitiveness, can only be achieved if intelligent and efficient use is made of available resources, such as energy, materials and personnel. The gap that will arise between the necessary increase in productivity and a growing shortage of resources must be closed by increasing efficiency.



The study of energy efficiency in production reveals areas in which future research can play a part.

Starting with an analysis of products, including the establishment of product categories, through process chain analysis including examination of materials processed, to the identification of prime energy drivers, the action required by production manufacturing technology was identified, from which the future need for research can be deduced.

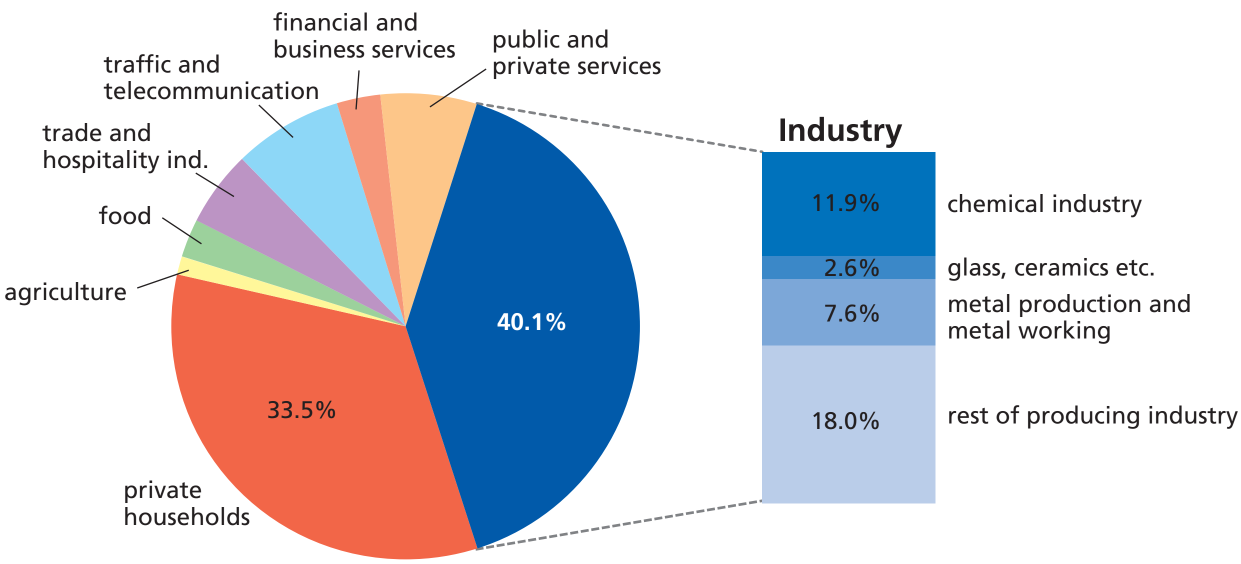
Our examination of "production site Germany" focussed on important industrial goods, which were subdivided into the product categories "premium investment goods", "premium consumer goods" and "mass consumer goods". The emphasis in this was on an examination of the efficiency with which the resource 'energy' is used from the viewpoint of process chains.

Industry accounts for about 40 % of total energy consumption in Germany. This is equivalent to an output of 5,640 petajoules per annum (2005). Of this, about 680 PJ/a corresponds to the study period resulting from the selection of the product categories named, of which about 30 % could be saved.

To exploit fully these potential savings, there is an urgent need for research and action, centred on the following key areas:

- energy and materials efficiency by increasing process stability
- energy and materials efficiency in mechanical, thermal and chemical manufacturing processes and systems
- closed cycle approach to resources / integration of resources in process chains and systems
- loss-free operation of infrastructure by produc tion facilities and factories
- development of methods for sustainable energy and materials management

These key areas will be described in more detail below.



Germany's primary energy consumption 2005 according to commercial activities;
Source: Statistisches Bundesamt; Umweltökonomische Gesamtrechnungen 2007

Energy and materials efficiency
by increasing process stability

Energy and materials efficiency
in mechanical, thermal and chemical
manufacturing processes and
systems

Closed resource cycles / integration
of resources in process chains and
systems

Loss-free operation of infrastructure
by production facilities and factories

Development of methods
for sustainable energy and materials
management

Energy and materials efficiency by increasing process stability

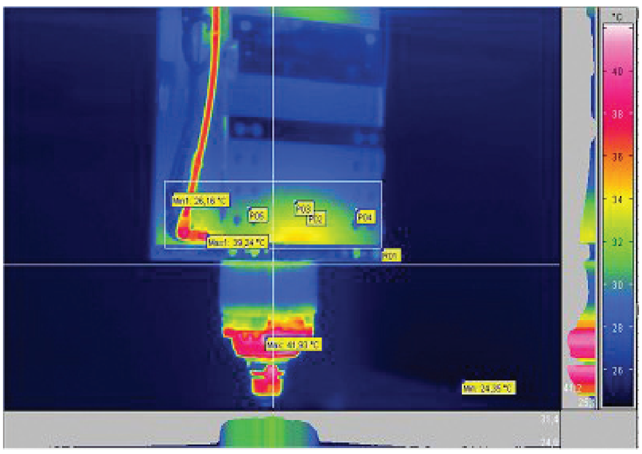
Undoubtedly the most important factor with regard to the conservation of resources is the saving of materials. Firstly, the use of materials is always associated with losses of material. Secondly, the cumulative energy expenditure introduced due to the material used, i.e. the energy expended to produce and manufacture the material, is an equally important aspect.
If one can succeed in avoiding the manufacture of faulty parts through "zero-rejects production", a significant contribution can be made to resource conservation. A particularly high proportion of rejects arises in all areas of machine and plant start-up. Research work and developments aimed at bringing manufacturing processes up to speed quickly and safely, and methods to increase process stability, contribute significantly to the conservation of the resources of time, materials and energy.

If there are rejects at the end of a machining process chain, one kilogram of component mass corresponds to an energy loss of 60 to 80 MJ.

If there are rejects at the end of a massive forming process chain, one kilogram of component mass corresponds to an energy loss of 45 MJ.

Control of start-up processes

Fluctuations in the process sequence due to disruptive factors such as inconsistent material characteristics or changing environmental influences frequently cause production faults, leading to reworking or rejection. This applies equally to start-up and restart-up processes of machines and plant in which the optimal operating parameters such as operating temperatures or working pressures, or even technological parameters such as workforce or feed speeds, have not yet been reached or set.



Temperature monitoring of a machine tool spindle

Costly reworking and rejects with a high value added element already incorporated give rise to a tremendous loss of all resources.

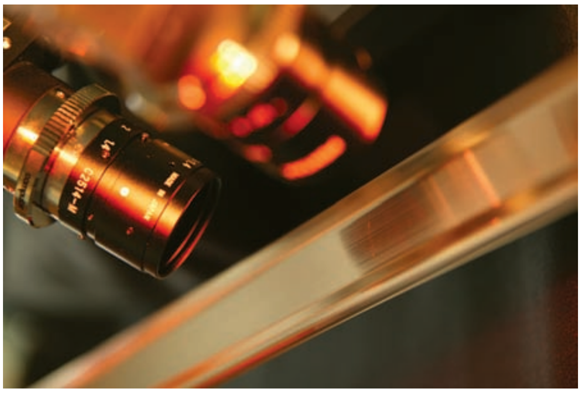
Machine status and the corresponding optimal operating range can be captured by developing and providing suitable methods of measurement. For example, monitoring the operating temperature combined with a warming up strategy shortens the time machines take to get up to speed, optimises the process and minimises non value-adding activities.

Process control to avoid resource losses

In the context of machine tools and forming technology, integrated feedback systems which can influence the control of the process can be seldom found.
Consequently, systems must be developed so that impending machine faults, the occurrence of process fluctuations and the resulting deviations are not only measured, but can also be compensated for or eliminated by control systems. The use of systems of control can not only shorten the unproductive time in getting machine and plant up to speed, but can also significantly improve operating and process safety.

The timely identification of process deviations and a correspondingly early reaction to them enable distinct savings to be made in all resource areas. The additional expenditure due to investment can be recovered within a very short time.

Another aspect not to be ignored is the option of one hundred percent quality control. One hundred percent monitoring also helps to minimise faults, even in processes that take place a considerable time later, and thus to save work and costs, and therefore resources.
To implement monitoring arrangements of this sort successfully it is important to thoroughly understand both the requirements of the machinery and also those of the technology in depth, and to understand the interactions that exist between them.



In this context, the effects of preceding processes must be taken into consideration just as much as the possible repercussions of proposed measures on subsequent process steps.
There is an urgent need for research above all with regard to a thorough understanding of process parameters, their modelling and simulation and to derive from this significant characteristics both with regard to multisensor data capture systems and multi-criteria control algorithms.

Potential savings vary markedly depending on the complexity of the machine and on the nature of the process. However, on account of the savings made in all resource areas they are extremely high in total.

Energy-efficient structuring of manufacturing processes by optimising servicing and maintenance cycles

A third approach to increasing process stability is Plant Asset Management, i.e. the extent to which it is possible to plan of measures to manage the plant and the process, as well as maintenance to preserve value, while at the same time minimising the work associated with this. The fields of Device Management, Condition Monitoring and Performance Monitoring must be more closely integrated in future, on both the technical and organisational level. This calls for the development of corresponding methods to ensure sufficient interoperability of different areas and progress from the use of a single machine to operating complex plant systems.

Functional properties of high-performance materials (e.g. ceramics) open up additional savings potential in the utilisation of energy over their entire life cycle. The use of long-lived, wear-resistant key components shortens or avoids idle times resulting from servicing and maintenance, and thus makes a significant contribution to the energy-efficient design of manufacturing processes.
To structure the manufacturing of high-performance components themselves in a more energy-efficient way, high-performance ceramic materials offer additional savings potential: to achieve the optimised design of a system, it is necessary to position certain materials properties precisely where they are actually needed. The development of interconnecting technologies specifically suited to the individual materials and stresses imposed plays a key role in this, because ever more complex processes and functions have to be realised in systems that are becoming smaller and smaller.

60 % of metal sheets (the starting material) in the automobile industry go to waste.

Every kilogram of steel saved in production corresponds to 6 to 21 MJ of energy saved.

Application of high performance ceramics cutting material

Energy losses in manufacturing processes are often accepted today as a necessary evil of high-quality production. In particular, processes which involve changes in material states, heat treatments or which are associated with high losses of material must be reconsidered in energy terms. As far as machinery and plant is concerned, major savings can be achieved by reducing primary loads and avoiding peak power e.g. using motors regulated by control systems, partial system switch-off and similar. As far as processes are concerned, the replacement of machining processes with forming processes can save material and at the same time shorten process chains with improved product quality. In the short term, processes can be optimised. In the long term, it is the task of research to replace energy- and material-intensive processes or even to eliminate them.

Heating one kilogram of steel to a temperature of 1,000°C corresponds to 0.5 MJ of energy.

Integrative production and process chain shortening

The increasing individualisation of products is leading to increasing complexity of components and is reflected in a large number of different manufacturing steps. In addition, the number of elements involved in adding value is rising, as companies concentrate on their core competences. The consequence is energy-intensive logistic processes between the individual value adding stages. The individual manufacturing steps are usually considered and optimised separately, without taking into consideration preceding and subsequent processes. This means that energy-intensive process technologies are not examined for their synergetically optimal utilisation of resources. There is inadequate consideration of the entire process chain. The potential to increase resource efficiency, e.g. by combining processes, often remain unexploited as a result.

To achieve improvements in this area, one must examine which technologies and processes can be combined efficiently, without allowing the newly created complexity to outweigh the advantages. Once rational process interfaces have been identified, tailored systems and processes can be developed to integrate functions. The objective must be to provide modular, easily configurable technology platforms to achieve the flexible combination of processes. The result would be that manufacturing flexibility and resource efficiency are increased by shortening the process chain.

In this way, for example, combining mechanical, jointing and heat-treatment processing can make major savings possible.

By shortening process chains and integrating processes, an increase in resource efficiency of up to 30 % can be attained, depending on the scope of the applications and their interoperability.

Reducing energy losses by control systems

Production plant is normally optimised in terms of installation costs and technological parameters; energy aspects are generally ignored. The efficient utilisation of energy has played hardly any role to date as far as control systems are concerned. Thus, most control applications provide no energy-saving modes, although they could be operated only seldom anyway due to the continuing lack of information.

It would make sense in energy terms, for example, to run accessory drive systems only when they are genuinely needed. However, this presupposes a knowledge of the machine status and, optimally, a knowledge of the entire production process.

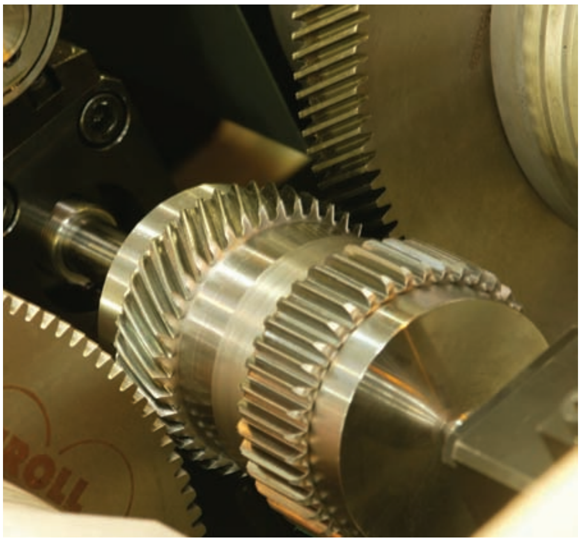
Action and research are needed in several directions: one area is the capture and processing of energy-relevant information for the recording and evaluation of energy-relevant parameters. To achieve this, the technical design of hardware and software is needed for sensors and IT structures with decentralised machine-machine communication solutions. The cost pressure in this segment must be considered as well: for systems to be accepted, for example, the costs of sensors must be reduced by a factor of 10 to 100 compared with conventional industrial solutions.
There is an urgent need for action in respect of integrating energy-relevant information at plant and factory level. The early identification of the start and end of idle times enables machines to be switched off and also on again at the right time.
Optimisation is possible by means of intelligent system monitoring, system diagnosis and self-correcting mechanisms.
Another starting point for a resource-saving machine is to design drives and structures appropriate to requirements and thus avoid over-dimensioning. Hybrid drive concepts appropriate to requirements need to be developed so that the parameters of the drive system can be adapted flexibly to suit the technological working points and the environmental parameters of the machine.

Studies of machine tools have revealed that the basic loads amount to up to three quarters of the total power consumption and only one quarter is consumed by the process itself. In addition, it can be assumed that machine tools are actually working for only 15 % of the operating time on small runs, and, in some circumstances, for up to only 40 % of the operating time on large runs. The remaining time is spent by the machine in a waiting state or on set-up time, during which it nevertheless runs at full basic load. Potential savings of 10 to 25 % are possible.

Energy-efficient forming and Net-Shape techniques

In many areas of manufacturing technology, machining processes are first choice on account of their flexibility. On the other hand, forming processes offer high materials efficiency, and therefore one should endeavour to make their use more widespread. This is possible by means of more flexible processes and tooling, even for quite small runs. Of course, many materials have to be heated to enable them to be formed, and a very large amount of energy is needed for this. It is therefore worth endeavouring to replace hot-forming processes with cold-forming processes. The use of new materials and the development of new technologies for cold or semi-hot forming will reduce energy input with the same or better component properties.
The objective of Net-Shape technologies lies in manufacturing the final contours of a product in the earliest possible stages of the value adding process and thus reducing secondary operations. Although these technologies cannot be qualified for all product specifications, they offer excellent potential for improvement from the energy viewpoint.
Research should concentrate on qualifying existing Net-Shape technologies for additional applications and developing new generative Net-Shape processes which can be combined with conventional manufacturing processes.

30 % of energy consumption by machine tools comes from stand-by operation to maintain process stability.



Manufacturing of gears by profile rolling

If a machining process is replaced by cold forming when using steel, for example, there is a savings potential of 6 megajoules per kilogram; with aluminium, depending on the proportion recycled, it is up to 100 megajoules. Other potential savings arise if hot forming is carried out at lower temperatures. A resource efficiency increase of up to 25 % can be achieved by generative (Net-Shape) processes. Further significant savings potential lies in the optimisation of frequently outdated equipment.

In plating (hard chrome plating), 3.3 kWh or around 12 MJ of energy per square metre are needed for a plating thickness of 1 µm.

Optimisation of painting and coating processes

Painting processes are carried out in many different application areas and sectors. The estimate is that there are about 100,000 paint processing plants in Germany. Major potential savings are to be expected with many painting processes. Thus, for example, the change from solvent-based liquid coatings to the more advantageous powder coating technology requires a degreasing process of substrate surfaces in addition in many cases, in order to attain the same paint adhesion quality as with a solvent-based paint. This involves heating the workpiece twice (for degreasing approx. 65°C, for drying residual water approx. 120°C).

Coating of washing machine bodies

In the sheet metal processing industry, powder coating takes place after machining (3-dimensional components), and this demands costly plant engineering.
In the areas of pretreatment chemistry and powder mould coatings for low-temperature applications, studies are needed to enable the powder mould coating of sheet metals to be carried out before machining (e.g. forming). Action is needed in the optimisation of bending tools and in adapting them to suit powder mould coating, and in relation to improving the expansion properties of powder mould coatings irrespective of the layer thickness achievable in each particular case.
Painting installations for metal plates or coils (2-dimensional workpieces) are considerably smaller and have significantly lower energy consumption, with their high throughputs in relation to unit area, than large installations for 3-dimensional components. There is therefore a major interest in the further development of fast and compact coating processes on 2-dimensional blanks or coils.
When coating products made from solid material (e.g. gearbox housings) the surface/component mass ratios are unfavourable. There is a requirement here for research into new coating and drying methods and paint systems, in order to reduce the heating of the entire component.

Taking into account the rational use of the existing most resource-efficient technologies and production methods, potential savings of approx. 25 % can be assumed, according to conventional estimates, depending on the further development of pretreatment, painting and powder mould coating systems or plant engineering.

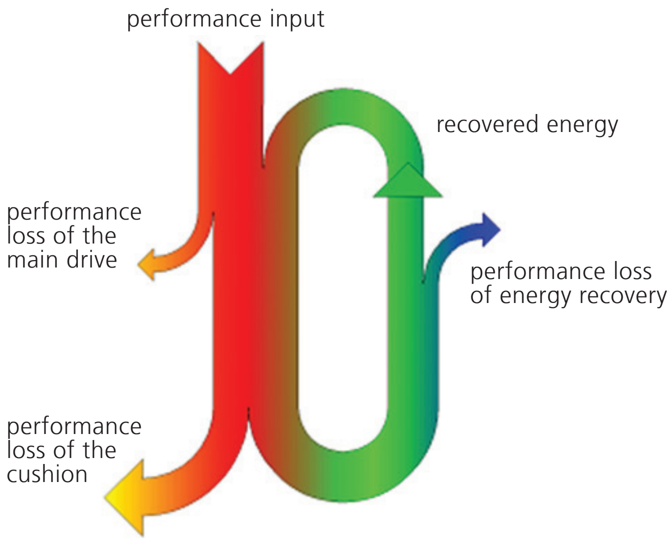
The utilisation of energy and materials in resource cycles in a closed loop is another important topic. In addition to the improvements achieved to date in the sphere of recycling and media provision, it is increasingly a matter of integrating resource cycles within process chains and within production communities generally. The latter is growing in importance particularly because the specialisation of companies is leading to less specific involvement in the manufacture of the finished product and therefore to a subdivision into possible cycles. In future, research topics in energy provision, transfer, conversion and recovery, as well as energy storage, must be linked more closely to machines and processes in the field of production, in addition to the areas of media provision dealt with hitherto. Examination and integration above and beyond process chains is tremendously important in this.

Energy recovery, conversion, transport and storage

Energy losses in manufacturing processes remain unavoidable even if all potential savings are exploited. In the segment of industry examined, energy is mainly lost due to being diffused into the environment as heat. If waste heat can be transferred efficiently into a fluid using technology available on the market, the "captured" waste heat can be utilised mainly only seasonally for space heating, as there are no possibilities of using it in appropriate quantity, at appropriate temperatures and at appropriate times in the manufacturing process. Energy recovery by short and direct routes requires the energy integration of machines and plant within a combined manufacturing step. Greater efficiency, suitability for difficult areas of application and low investment costs are development objectives in the field of heat transfer and transport technologies, in order to make greater %ages of diffuse losses in the process as a whole economically exploitable. One example that could be mentioned is the nanocoating of heat exchange surfaces. To match the waste heat generated to the demand for process heat at the right time and in the right quality, innovative heat reservoirs and circular processes fit for industrial application are required to convert low-temperature heat into higher value process energy.
Interesting fields of development are sorption-driven heat pumps, refrigerating machines and heat transformers, as well as electricity generation from waste heat, for example Organic Rankine Cycle installations for industrial applications.
In the case of mechanical losses due to braked masses, the mechanical energy should be recovered directly within the drive system via storage systems.

The current potential for economically worthwhile research areas in the considered industry is estimated at approx. 20 PJ of primary energy saving. It is worth pointing out the synergy between the technologies mentioned in the previous paragraph and research in the area of regenerative energy technology.

In the sphere of hot forming, practically the entire energy used for heating is lost energy. This is equivalent to 166 KWh or 600 MJ per tonne.



Recycling

The use of recycling materials from production waste makes a significant contribution to improving energy efficiency. This contribution results predominantly from the distinctly lower use of energy required for the production of secondary material.

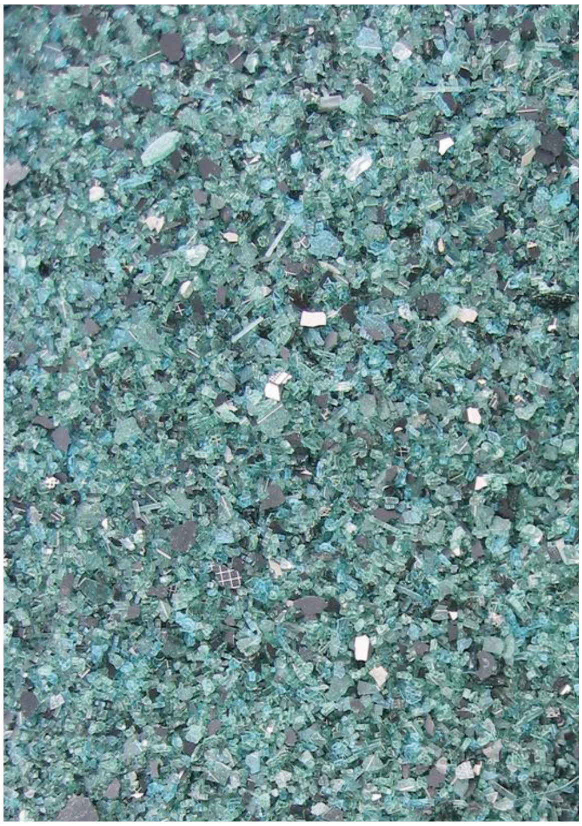
In the ideal situation, recyclable material from production can be utilised further without further energy-intensive melting processes or similar, thus further improving energy efficiency. There is a large potential in metal processing, especially in the area of sheet metal and stamping waste. For example, up to 60 % of metal sheets used in automobile production end up as production waste. The same applies to other areas. One example that can be mentioned is the production of industrial glassware. At present, no secondary material is used due to a lack of suitable recovery and recycling logistics systems, because high-quality, unmixed recycled material is needed for this purpose.

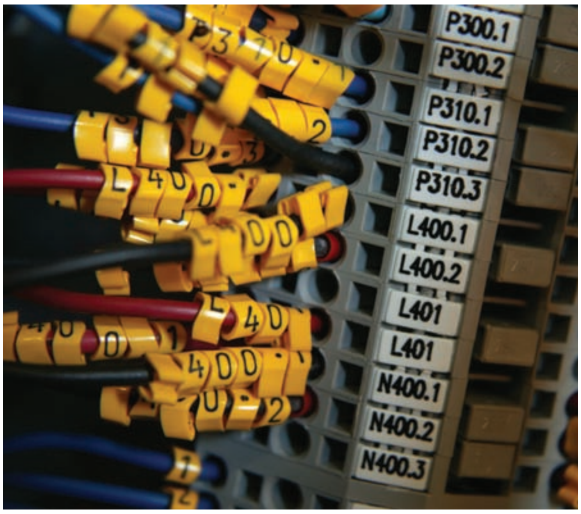
The re-use of secondary aluminium needs only 1/5 of the energy necessary to produce primary aluminium.

Only about 1/3 of the annual consumption of steel, copper and aluminium in Germany is covered by secondary material.

There is an urgent need for action and research with regard to the development of intelligent recycling concepts for production waste either within the processing unit itself, through collaborative arrangements across the company, or by setting up systems to capture and recycle unmixed materials, such as industrial glassware and aluminium, for example. The objective is to reduce the levels of primary material use.

Sheet metal and stamping waste is currently fed into steel recycling via scrap metal dealers. The direct re-use of this waste has happened only marginally to date in individual companies. Detailed figures on this are not yet available. There is also a great potential in industrial glassware, because there is currently no recycling of the appropriate types of glass.





The energy consumption and the energy-efficient production of goods in a supply chain have played only a very subordinate role to date; the repercussions of energy-related parameterisation of a production network on the conventional logistical target variables have hardly been studied at all so far. Important tasks in this area are therefore the creation and verification of "energy supply chain" models and the analysis of their repercussions on the production networks. At the same time, supply chain management and conventional logistics or intralogistics will have to come closer together and also include aspects of supply and peripheral processes.

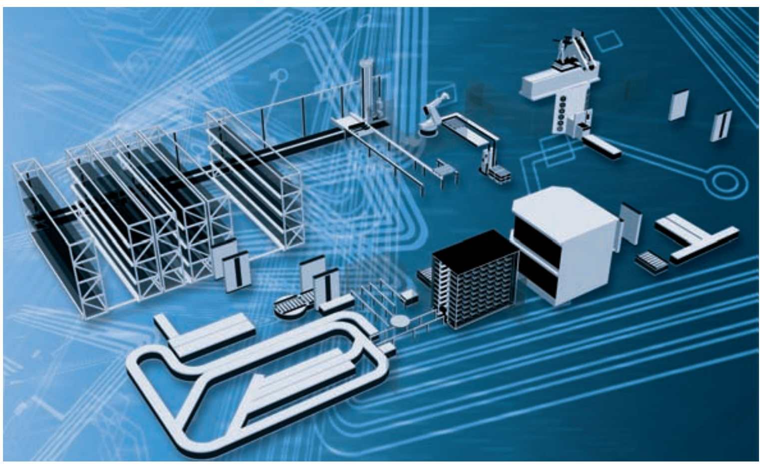
Supply chain-management

To arrive at an integrated evaluation and optimisation of energy efficiency in production, it is essential to include in one's considerations the production environment, in addition to manufacturing technologies and machines. At present, energy aspects are only inadequately taken into consideration in the distribution, structuring and evaluation of added value in production networks. Energy consumption and the energy-efficient production of goods in a supply chain play only a subordinate role. Admittedly, the optimal structuring of information and material flows within a production network is central to supply chain management; however, integrated supply concepts for media, energy and other manufacturing supplies do not exist.
Over all, the supply chains are structured exclusively according to classic logistics target variables. Taking the interdependences of these target variables into account, companies or company networks endeavour to achieve the greatest possible economy in their logistics processes.
The repercussions of energy-efficient parameterisation of a production network on classic logistics target variables are not yet known. Conventional site evaluations, for example, concentrate on costs, labour forces, statutory obligations, topography etc., among other things, whereas energy aspects such as the utilisation of energy-efficient traffic routes or possible access to alternative energy sources are hardly considered.

The identification of potential energy savings in supply chains has not been possible so far, although it is predicted that considerable energy-saving potential exists in this area. The development of appropriate methods should therefore be a task for future research projects.

The production environment including the transport of goods accounts for a predominant part of the energy consumption in the area under consideration in the study, at over 40 %.

1 kilowatt of electricity saving means 1.5 kilowatts of primary energy saving.



Up to 40 % of the energy can be saved in the generation of compressed air by converting and modernising the plant.

Energy-efficient supply systems and structures in the factory

The transformation process to yield percentages of added value is inconceivable without the supply and disposal systems of the factory's infrastructure. The supply or infrastructure systems provide mainly industrial media such as water, electricity, natural gas, heat/cold, compressed air, cutting oils, industrial gases etc. for production techniques and processes. The requirements are mainly specified by the production systems. In addition, the production environment and the product itself set additional requirements, e.g. for lighting, cleanliness and air conditioning. The optimisation in these matters is pursued locally in the sphere of supply systems at individual points or on individual systems. An integrated approach between the supply systems and the production systems hardly exists. All the supply systems and structures today are the subject of projects that are for the most part independent of other supply or production systems.
To achieve further increases in energy efficiency in this area, a systemic approach to the integrated planning and optimisation of supply systems and structures must be developed. The aim must be to attain an overall optimum via the exploitation of synergies, in order to set up energy-efficient supply and production structures in factories.

Increasing energy efficiency through local optimisation of individual systems and structures is already showing notable savings potential. Integrated analysis, planning and design are the next logical step.

The results achievable are dependent very largely on the preconditions that exist. However, in general, savings similar to those with local optimisation can be expected, which average 20-30 % at present.

Intralogistics

In spite of the proven high potential for savings and rationalisation in intralogistics, energy efficiency is left in the background in the planning of intralogistics systems. In the designing of material flow systems, energy costs have been estimated on a flat-rate basis to date (in general, as a percentage of investment costs, often approx. 3 % p.a. for energy costs). No schedule is prepared of the energy costs depending on the conveyor systems and storage facilities used and their arrangement or their interaction in the system, because the key values necessary for this are not available. At the same time, focussing on the investment costs inhibits the spread of systems optimised for consumption. In addition to the availability of precision values for technical system alternatives, the creation of new drive and operating concepts which will enable alternative drive concepts to be developed is a significant building block as far as the diffusion of energy-related design principles in intralogistics is concerned.

In the area of electrical drive systems alone, an annual electricity saving of 27,500 million kilowatt hours is possible, according to the ZVEI (German Electrical and Electronic Manufacturers' Association), through the use of energy-saving technologies. Due to the large number of electrical motors used in conveyor systems, which crucially determines the processes within intralogistics systems, the potential saving is up to 30 % of the total electricity saving predicted by the ZVEI.

For resource-efficient production, all sources and sinks must be recorded as a whole. Much wasteful use of resources cannot be countered at the present time, simply because it cannot be located or measured. Investment plans are made mainly on the basis of investment cost. It is therefore necessary to add tools and methods, which will capture as completely as possible the relevant variables with regard to energy and materials, and which will make it possible to evaluate, plan, optimise and reduce consumption in both the investment and operating phases, to the existing key value systems of factory and facility planning.
Total Energy Management is understood to mean the integration and extension of the various methods to the planning and control of factory and production systems and their processes with a view to reducing energy consumption.

Value Added Management of Energy

There are as yet hardly any robust consumption values which can be assigned to individual technologies or consumers. They are captured by meters only in the case of systems which have high energy consumption per se. In addition, there is a lack of methods/criteria which allow a comparison to be made between the systems in different companies.
To develop characteristic value systems for energy consumption, criteria and guidelines for the measurement of resources and energy consumption must be developed that are appropriately coordinated with the characteristic data of the operational process.
The absolute quantity of resources / energy cannot provide a starting point for benchmarks in this context without reference to another value. This is why a methodology or a guideline must first be developed for production and infrastructure technologies (logistics and supply systems), which will permit a comparison to be made on the basis of measurement, even in different companies.

Energy-efficient installation components or technologies can be used quite deliberately at the planning stage, on the basis of qualified and evaluated key values that will be available in the future. The uncertainty that obtains in companies at present in this regard will be eliminated.

Key values relevant to resources or energy are recorded only in rare cases, and when they are, they relate to selected areas of production and to energy or media supply. Action is needed to work out an overall systematology/methodology of evaluation for the identification of energy-efficient technologies and for the assessment and economic optimisation of the energy efficiency of process chains in production engineering, both company-specific and applicable to several companies.
The methods for production-related planning, existing evaluation systematologies and methods of input/output analysis planning of energy consumption must be combined together in the nature of a modular system of methods.

The evaluation systematology worked out should be used to assist in identifying potential synergies with regard to energy and materials consumption, i.e. the targeted provision of process technology, supply technology and materials on request should be made possible and optimised.

At present no robust figures can be quoted for Total Energy Management (TEM), because this is not yet being practised. When the experts were questioned, however, TEM was judged an important possible solution to increasing energy efficiency.

In the course of the study, product development and human resources turned out to be closely linked and also important aspects for the efficient handling of resources.

Prospective product development

80 % of product costs are tied up in the product origination process. Using concepts such as "Design to Logistics" and "Design to Recycling", the attempt is made to take account of aspects of logistics and recycling at the product development stage. The problems of energy and resource efficiency have so far been given little attention in this context.
The early identification of resource-efficient product, production and materials technologies is essential to enable resource efficiency in the manufacture of products to be taken into consideration in the course of product development.
In particular, questions that need to be answered are how ecological trends can be taken into account in technological considerations and how young, resource-efficient, but not yet qualified technologies can be evaluated, planned and implemented. In addition, procedures must be developed to generate and to safeguard knowledge about resource-efficient technologies.
Accordingly, methods and outline plans must be developed which ensure that attention is paid to resource efficiency aspects in product development.

If resource-efficient technologies are taken into account early at the product development stage, savings of between 10 and 40 % are possible, depending on the sector and product.

Human resources

The increase in energy efficiency in production can only be pushed forward and implemented by the players within the company themselves. Three factors of influence are decisive as far as this process is concerned: the will, the competence and conducive organisational circumstances.
The following actions can be identified as being required:
Organisation: embedding the subject of energy efficiency into existing processes, structures and responsibilities or creating new functions, incentives and working practices.
Qualification: providing specialist knowledge which must be drawn up for different target groups, and carrying through corresponding further education measures.
Culture: changing action-determining attitudes and perceptions of company players to increase the probability of implementation.

Further education and organisation can systematise and accelerate the selection, introduction and implementation process. One can expect that acceptance and the masterability of new solutions will grow and, at the same time, that the company's energy and therefore cost savings will increase significantly.

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