Energy efficiency in European industry

Chemical industry

Introduction to the chemical sector

The chemical sector consists of the NACE sector code C20 (*"Manufacture of chemicals and chemical products"*), and often also C21 (*"Manufacture of basic pharmaceutical products and pharmaceutical preparations"*). Some of the subsectors in the chemical industry are highly energy-intensive, mainly the subsectors of petrochemicals and basic inorganic chemicals.

GP **Nitrogen generation and recovery**

In plants for nitrogen production, as well as other chemical installations in which nitrogen is produced as a by-product, significant energy savings are possible. In situations where nitrogen is needed as a feedstock, traditionally liquid nitrogen is transported to the location. By construction a gaseous nitrogen production plant 'on site', transport is avoided and nitrogen phase changes do not take place.

In installations where nitrogen is produced as a by-product and dispersed into the atmosphere, nitrogen recovery can be applied. The recovered nitrogen (in gaseous state) is subsequently compared to a pressure of 16 bar and delivered through the distribution network designed in order to reduce the consumption of liquid nitrogen.

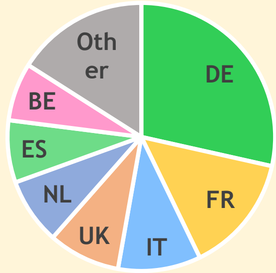
In the nitrogen generation and recovery examples as reported in the EU-MERCI database, it is shown that these practices can lead to substantial energy consumption improvements of more than 50%, and in some cases even up to 80%. *more info*

GP **Replacement of mercury-cell electrolysis**

Under the Best Available Techniques conclusions of the EU Industrial Emissions Directive, mercury-cell electrolysis in the chlorine-alkali industry had to be phased out by December 2017. The EU-MERCI database contains two examples of the replacement of mercury-cell electrolysis by membrane-cell electrolysis.

This substitution results not only in the elimination of mercury release into the environment, but also in energy savings. On the one hand, for membrane-cell electrolysis more hot steam is needed, resulting in an increase of natural gas consumption. However, this is more than compensated by a significant decrease in electrical energy use. The average aggregate energy consumption improvement as a result of introducing membrane-cell electrolysis has been 36%. *more info*

Statistics EU chemical sector



The seven countries mentioned in the diagram cover **84%** of the EU's chemicals production value. More than a quarter of chemicals is produced in Germany

Statistics for chemical and pharmaceutical industry combined:

- **32,400 enterprises**
- **1.58 million people employed**
- **Gross added value € 190 billion**
- **Final energy consumption: 51,495 ktoe per year (18.9% of EU industry energy consumption)**

As one of the few industrial sectors, the energy consumption from the chemical sector is expected to continue to increase. Global demand for chemicals is forecast to grow on average by 4.5% annually until 2030, and the EU, as a key exporter, is expected to support this need. Energy intensity is however expected to decrease only marginally.

Most of the interventions for energy efficiency in the chemical sector in Europe have taken place in the basic chemicals and 'other chemical products' subsectors.

Out of about 340 interventions analysed, the most common types of interventions have been on motors and drives (23%), followed by process design and optimisation (18%), heat recovery and cooling (15%), and compressed air measures (14%). However, when it comes to the resulting energy savings, by far the most effect is sorted by process design optimisation, responsible for a share of 59% of energy savings.

High costs for energy efficiency

Although most energy savings measures in the chemical sector were generic interventions such as on heat recovery and cooling or compressed air measures, much more effect is sorted by the smaller number of process-related interventions. This illustrates that, while standard measures can provide some quick-wins, for large-scale savings far-reaching process interventions will be needed.

The average costs as registered in the EU-MERCI database for process-related interventions has been high, at € 4,463 per tonne of oil equivalent (toe) saved per year. This compares to an average cost of only € 467/toe/year for the generic measures.

GP **Interventions in sodium carbonate production**

The process of calcination is used for the decomposition of sodium bicarbonate to create sodium carbonate. Several interventions have been implemented to optimise the calcination process, and related processes in a sodium carbonate production plant. The calcination process is not only used in the chemical sector, but also for example in the cement industry (for the decomposition of calcium carbonate). The suggested interventions therefore have possible applications in various sectors.

Possible interventions include the improvement of the raw materials preparation and loading, such as loading of the limestone and of the coke/anthracite in layers to have always the correct quantities and proportions; or installation of servo-motorised doors on the loading hoppers. Alternatives are related to the improvement of the calcination process itself, such as recovery of the non-completely converted limestone with a scale that measures that they have the correct size to be recycled directly in the furnace and chemical analysis to verify their quality, or the installation of an automated control system.

A combination of various of these interventions in a chemical plant in Italy led to an energy consumption improvement of 11%, with a payback time of less than a year. *more info* PDF

GP **Improved distillation of styrene**

0.6
years
payback time

Styrene is an organic compound that is usually produced through dehydrogenation of ethylbenzene. Because styrene and ethylbenzene have similar boiling points, their separation requires tall distillation towers, high return/reflux ratios, and a very energy-demanding distillation process. The use of non-conventional distillation columns can generate significant energy savings and thereby significantly reduce the costs compared to conventional sequences.

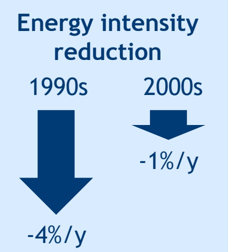
Optimisation of the distillation column in a styrene production plant is done by removal of the upper bed and the head distributor, to be replaced with two beds and two flow distributors, in order to increase the number of stages and so reduce the energy needs of the system.

The new asset of the column could reduce its specific steam consumption, generating a qualitatively improved product, which can improve energy performance also in other stages of the production process.

The improved distillation process leads to an improvement in the energy consumption of some 23%. With an average payback time of only about 7 months, it can be considered a no-regret intervention in the production process of styrene. *more info* PDF

Recommendations: process interventions

Support schemes have generally achieved relatively poor results in the chemical sector as compared to other sectors. This can be explained by the high investment costs required. The sector seems to react better to training-based schemes and voluntary agreements than to energy efficiency obligation schemes, as the latter – because of the complexity and high costs of process interventions – mainly sorts effects in smaller generic interventions.



As many of the possible generic interventions ('quick wins') have already been implemented, energy intensity reductions have decreased over recent years. Between 1990 and 2000, the energy intensity reduced by about 4% per year, but in recent years this has decreased to only about 1%. To guarantee a continuing (and increasing) reduction of the sectoral energy intensity, a focus on the more complex process-related interventions is needed.

Considering the high energy consumption in the chemical sector, combined with the need for complex and high-cost interventions, a focus should be on voluntary agreements in combination with financial support, in order to ensure a turnaround in the sector.

Policies

In many EU Member States, the chemical industry is covered by an energy efficiency obligation (EEO) scheme, but also many alternative measures have been implemented, including financial schemes and fiscal measures.

In various countries, voluntary agreements have been made between the government and the chemical sector (or all energy-intensive sectors). Such agreements have been made for example in Belgium (both Flanders and Wallonia), Finland, the Netherlands, Sweden, and the UK. In voluntary agreements, enterprises often receive tax rebates in return for energy consumption improvements. One of the objectives of such agreements is often also to decrease the energy intensity of the production process, while protecting the market position of domestic industries in the face of international competition.

The EU-MERCI project

EU-MERCI is an EU-funded project aimed at supporting the growth of energy efficiency in industry processes. The project shares good practices of energy efficiency measures, helps industry actors to overcome expected barriers and maximise benefits, and supports policy makers. → eumerci.eu.

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