

# Ecological Aspects of Ferroalloys and Silicon Metallurgical Works – Economical Solutions

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## Abstract

*The future holds a great potential for the field of energy and environmental solutions in metallurgical processes. SMS Group brought different innovative concepts to market and has been awarded for several of these new technologies.*

*Raising requirements for sustainable and cost-efficient production of metals lead to a growing demand for energy recovery solutions and the usage of combustible exhaust gases. Therefore we offer an integrated solution how to use different energy sources available in a metallurgical works complex most efficiently. Energy recovery systems work for open/semi-open type SAF off-gas heat or converter heat while process gases from closed type SAF are utilized in steam generators.*

*All metallurgical processes generate exhaust gases which contain thermal and to some extent chemical energy. To use the thermal energy, we developed a Waste Heat Boiler enabling to regain up to 80% of the otherwise lost energy – typically using off-gas with temperatures up to 700° C.*

*Furthermore metallurgical processes yield a large range of gaseous byproducts like SAF-gas, blast furnace gas, coke oven gas and converter gas that have high energy content in the form of combustible components like Co and H<sub>2</sub>. Utilizing these gases as primary fuel in a firing plant contributes significantly to increased energy efficiency in steelworks, and therefore reduces the overall metal production costs and saves CO<sub>2</sub> emissions. For the systematic utilization of these gases to generate e.g. steam for production and/or to generate electricity in a complete power station process, SMS Group offers a wide range of part-standardized Industrial Steam Generators.*

## 1. ecoplants concept

The challenge of reconciling sustainability and economic growth must be addressed in practically all the world's markets. It is also playing an increasingly important role in the metal industry due to comparatively great potential for saving energy of the latter.



**Figure 1:** ecoplants logo

The new ecoplants label is the new label for sustainable solutions by SMS Group.

The combination of sustainability and economic growth is the result of four ecoplants- criteria:

- Significant reduction in the use of raw materials
- Significant reduction in the use of energy and operating media
- Significant reduction in emissions
- Significant improvement in the recycling quota

## 2. Utilization of waste heat at SAF

For more than 100 years it has been our business and tradition to work out solutions in the field of submerged-arc furnaces and electric smelters. Our technology assures the success of our customers in the ferroalloy and non-ferrous metal industries. Our plants are characterized by innovative design and “Made in Germany”-qualitative manufac-

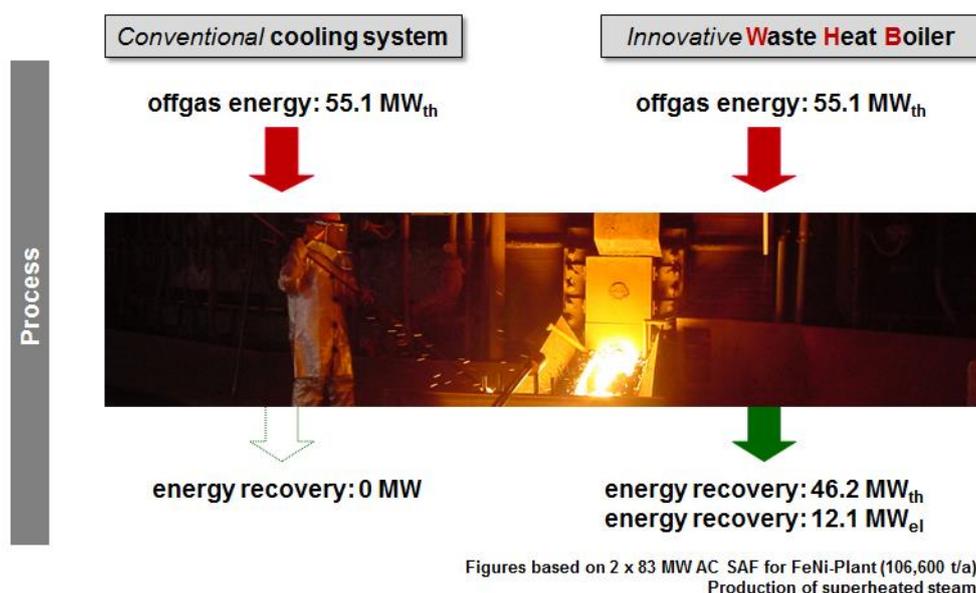
turing. References from all over the world demonstrate the economic success which is achieved through stable and safe operation.

Along the metallurgical production processes, there are several operating sequences that require enormous amounts of heat. These accumulated, hot exhaust gases often remain unused.

Based on this background SMS has developed energy recovery systems producing steam from exhaust gases coming from different furnances - e.g. SAF and AOD-Converter. Depending on the process up to 80% of the wasted energy can be recovered. This steam can be used for heating, cooling or generation of mechanical or electrical energy.

Forced by these technologies, tens of thousands of tons of CO<sub>2</sub> emissions are saved, which allow the disposition of emission permits.

In semi-open electric smelters, the combustible components of the process gases are fully combusted in the free-board area above the burden. Today's furnaces are equipped with doors allowing the precise control of the off-gas temperature between 550 to 750°C. Instead of cooling the off-gas by means of a forced draft cooler or a hair-pin cooler the energy of the off gas is utilized to generate superheated steam within a waste heat boiler. Inside the waste heat boiler convective heating surfaces are located. The boiler consists of heating surface tube banks for economizer, evaporator and superheater. The upper part of the boiler casing consists of water walls and belongs to the evaporator system. This measure leads to a very high flexibility of the system in case of off gas temperature peaks etc. The boiler will be operated in natural circulation thus no circulation pumps are required.



**Figure 1:** Energy Recovery at SAF – Open furnace design

In any way the cooling is necessary before the gas can be cleaned in the bag filter. Now, by using this energy recovery plant, superheated steam is generated. The produced steam can be utilized for various applications, e.g. for generation of electricity, for heating or for running drives.

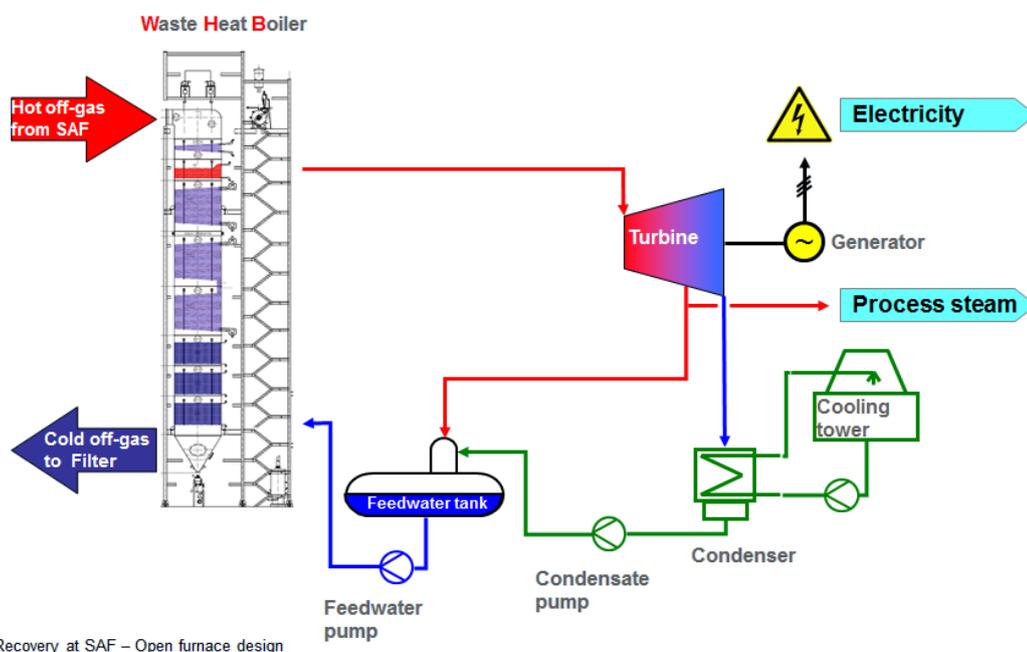
EtiKrom is a Turkish ferrochrome producer who has placed an order for two additional reduction furnances (SAF) from SMS Group. Both of them are equipped with energy recovery systems using thermal energy from up to 600°C hot furnace gases for generation of superheated steam. The energy content of the steam is used to drive a steam turbine which produces electrical power with a 5 MW-generator. EtiKrom is expecting an amortization period of less than four years by this method of producing electrical power.

<b>Scope</b>	Energy recovery system including a complete gas cleaning technology for two FeCr-SAF at <b>Eti Krom</b> .
<b>Brief description</b>	The energy from the approx. 600°C-hot exhaust gas is converted into superheated steam. By using this steam a turbine generating 5 MW of electrical energy is driven.
<b>ecoplants-criteria</b>	<p><b>Ecological advantage:</b> Recovery of 11% of the total input energy; saving of around 25,000 tons of CO<sub>2</sub> p.a.; Previously: no dedusting, today: max. 10 mg dust / Nm<sup>3</sup> in the offgas.</p> <p><b>Economic advantage:</b> Power generation: approx. 3.8 mio € p.a; Amortization period: approx. 3 ½ years.</p>



**Figure 2:** ecoplants– solutions for our customer EtiKrom

In some Si-metal and FeSi processes up to 22% of the input electric power can be recovered.



**Figure 3:** Typical flow chart – energy recovery system

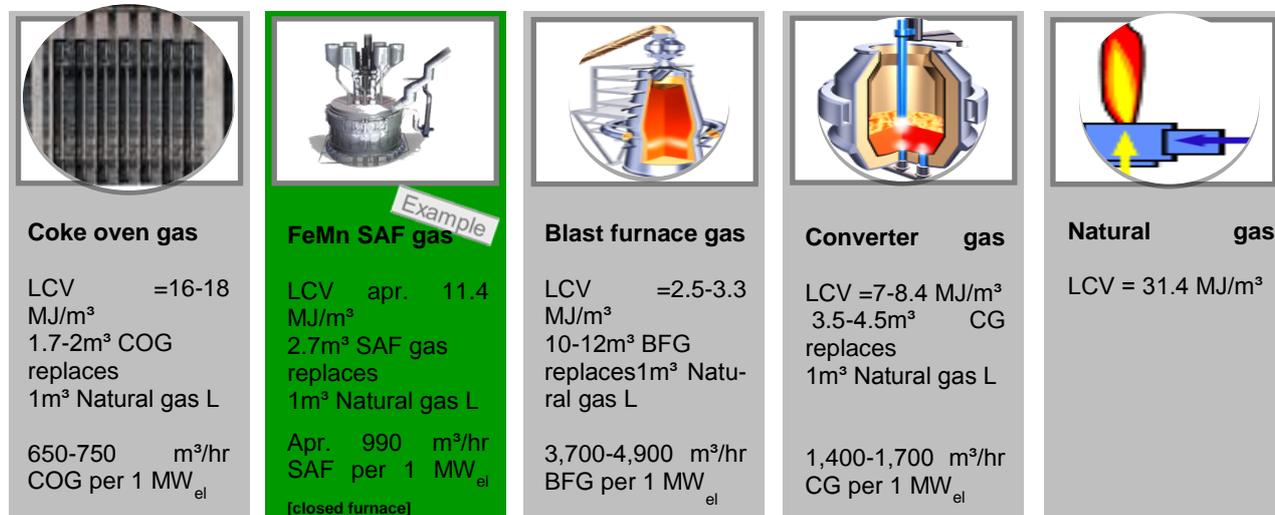
### 3. Usage of exhaust gas

The large range of gaseous byproducts as SAF-gas, blast furnace gas, coke oven gas and converter gas have high energy content in terms of combustible components.

At semi-open type furnaces the combustible components which are generated during the process are fully burned in the freeboard area. The furnaces are either equipped with doors or openings in the roof, which allows the control of the off-gas temperature. Depending on the process the off-gas temperatures are between 550 to 750°C. Internal calculation shows that more than 20% of the input electric power can be recovered. Due to environmental and ecological reasons, a larger portion of electric smelters are closed type furnaces, which produce certain quantities of CO-rich gas that can be utilized in various up- and downstream processes. SMS developed a “dirty-boiler-system”, which can take the hot dirty combustible gas and transform the chemical and sensible heat into steam.

Having a closer look at SAF-gas in a closed furnace design one would not find combustion of process gas.

But combustible off-gas can be used after treatment (e.g. Venturi Scrubber) in a Process Gas Boiler to generate superheated steam. The off-gas flows about 6,000 to 12,000 Nm<sup>3</sup>/h. Depending on alternating current or direct current the high dust load ranges between 70 and 200 g/Nm<sup>3</sup>, temperatures start at 300 up to 1,800°C maximum. Utilizing gaseous byproducts in general as primary fuel in an industrial power plant contributes significantly to increased energy efficiency in steelworks and therefore reduces the overall steel manufacturing costs and reduces CO<sub>2</sub> emissions.



**Figure 4:** Specific values for different process gases

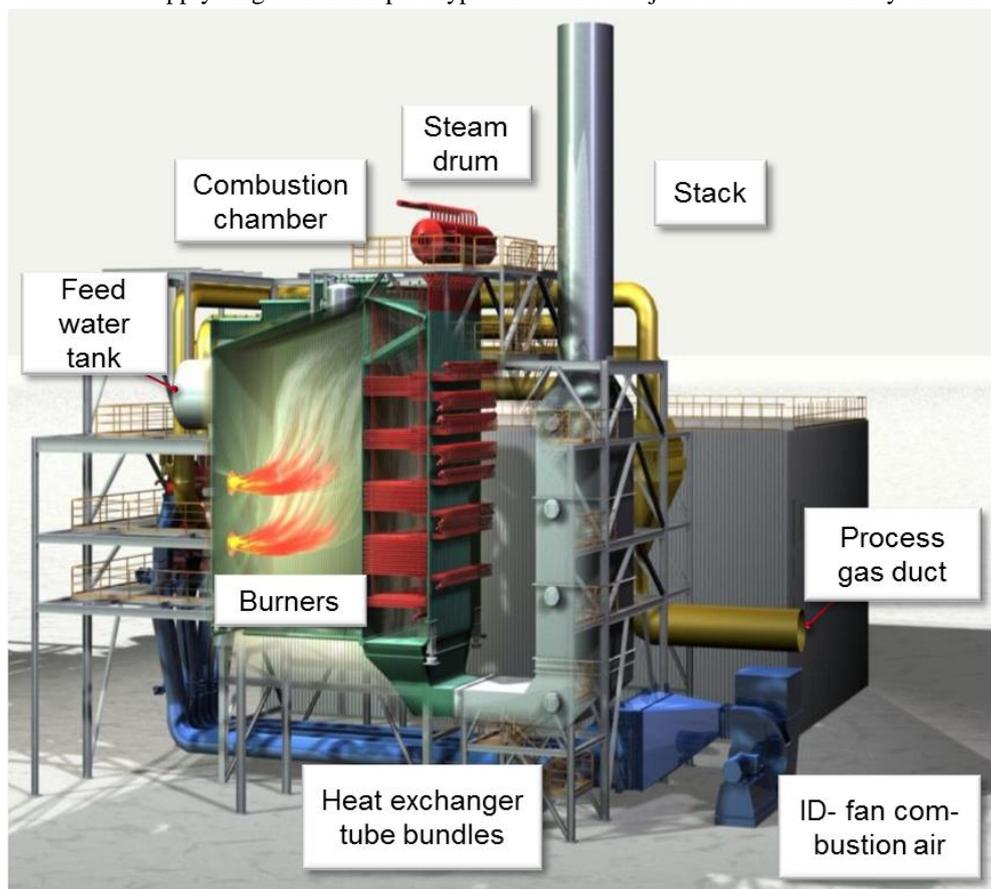
For the systematic utilization of these gases, e.g. to generate steam for production and/or to generate electricity in a complete power station process, SMS Group offers a wide range of part-standardized steam generators. In this context SMS focuses on taking into account many requirements that influence the choice of steam generator type. Examples for these requirements are:

- Low emissions
- Wide range of fuels
- Compact design
- Fast starting capability
- Flexibility:
- Variable and fixed-pressure mode
- Daily start/stop
- High availability
- High cost-effectiveness

The SMS Group range comprises suspended or self-supporting natural-circulation steam generators with high to top outputs:

- Live steam pressures up to 160 bar
- Live steam temperatures up to 540°C
- Up to 150 MW<sub>el</sub>

We supply single or multi-pass types that can be adjusted to a wide variety of tasks.



**Figure 5:** Typical two-pass steam generator

Existing plants have a high potential for the optimization of air- and fuel supply. Low calorific gas burners often operate with conservative combustion parameters that are highly prone to failures, which can lead to increased downtimes. Our experts have the required know-how to optimize these burners and to ensure smooth operations.

#### 4. Conclusion

By combining the ecological benefit with an economical advantage the SMS Group energy solutions are awarded with the SMS *ecoplants* label. Due to increasing costs for energy, measures to reduce the energy consumption as well as energy recovery solutions are getting more and more important. All melting aggregates hold a reasonable potential for waste heat. It becomes a must to recover this off-gas energy.