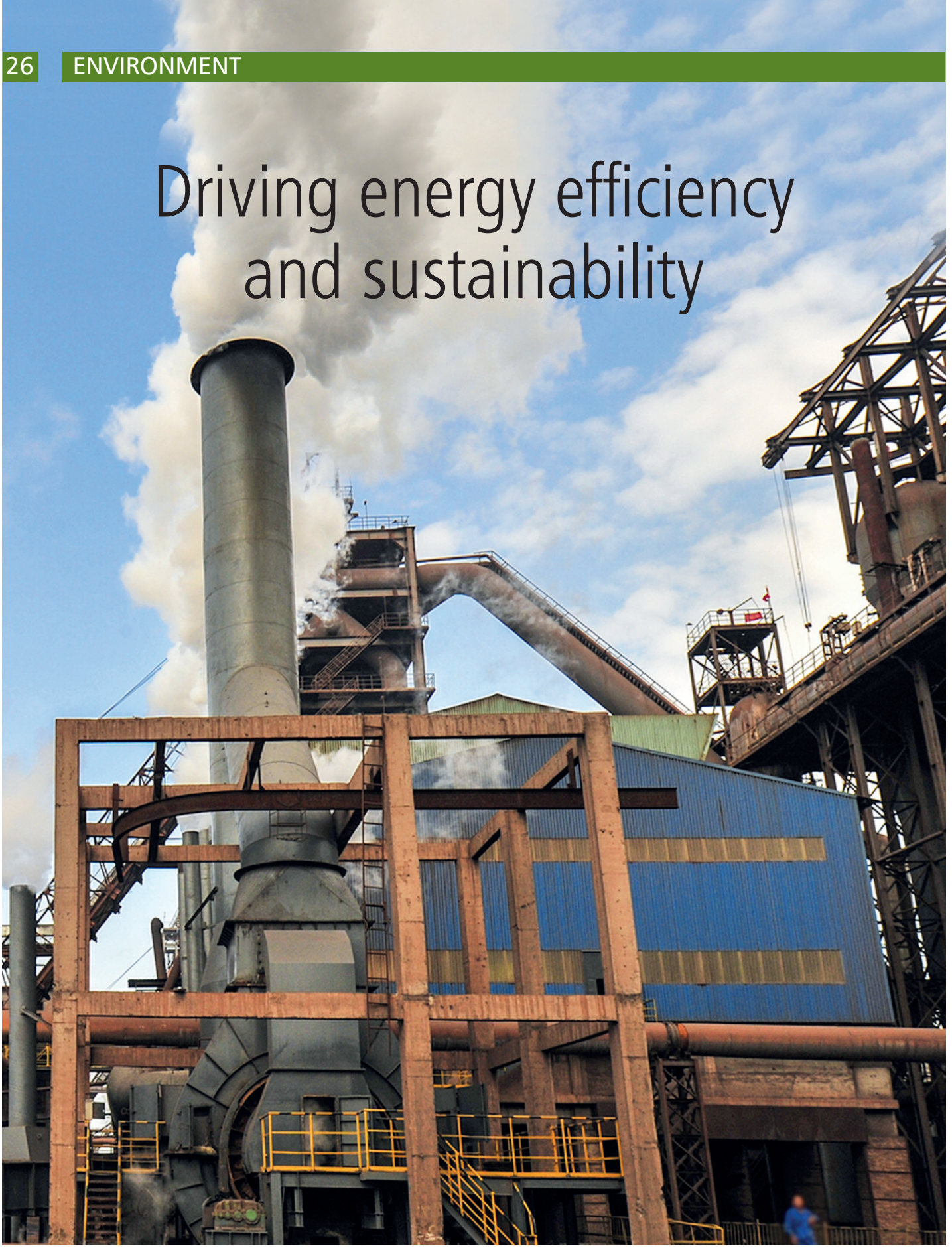
Driving energy efficiency and sustainability



High-efficiency motors combined with variable speed drives (VSDs) have a crucial role to play in reducing iron and steel plant energy costs and meeting environmental targets. **Pasi Mannisto*** examines these issues from the perspective of motor and drive specialist ABB.

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SUSTAINABILITY is the number one challenge facing this industry over the next 20 or so years, as envisioned in Metals 20401 – a report jointly published by Aalto University and ABB. Its authors paint a clear picture of a technologically advanced and sustainably managed world and set out the changes necessary to maintain success in it. According to the Energy Transitions Commission (ETC)[2] in 2019, iron and steel companies were emitting a massive 2.3 Gt of carbon each year – accounting for 7% of today's total global carbon emissions. The Iron and Steel Technology Roadmap[3] published in 2020 by the International Energy Agency (IEA) notes that steel industry emissions must be cut by at least 50% between now and 2050 to meet global energy and climate goals.

Additional pressures in the form of carbon taxes and increased energy and fuel prices threaten the profitability of businesses. In response, they need to look for more efficient and sustainable solutions in every aspect of their operations – including their use of electric motors.

Motor-related improvements

According to a US report[4] motor-driven equipment uses around 7% of the industry's overall energy consumption. Therefore, its contribution to CO_2 emissions may seem small compared to that of blast furnaces, for instance, but it is still significant. Furthermore, a large proportion of the energy consumed by these motors is wasted – in some extreme cases as much as 70%. Here there are opportunities to make readily achievable gains. The scope for change is very wide, as electric motors are found in many applications within iron and steel plants. Examples include hot and cold rolling mills, blowers, fans, pumps, compressors, roller tables, conveyors and other materials handling systems such as overhead cranes.

Importantly, these motors should be controlled by variable speed drives (VSDs) to maximise their operating efficiency. An essential advantage of this arrangement relates to the fact that in applications such as centrifugal pumps and fans, the motor's power consumption is proportional to the cube of its speed, while there is a quadratic relationship between the speed and torque. By matching speed to actual demand, rather than running the motor at full speed all the time, huge savings can be made. A fan or pump, for example, can be precisely regulated to deliver the required flow at any given moment. In practice, cost reductions of anything up to 60% have been achieved, with payback sometimes taking less than a year.

By avoiding unnecessarily high speeds, and smoothing out start-ups, VSDs also reduce wear and mechanical stress on machinery – and hence save on maintenance, repair and downtime expenses. When selecting motor and drive combinations, buyers should consider build quality and reliability, along with efficiency, as keys to lowering lifetime costs. In addition, choosing those with the most accurate control and dynamic performance will optimise processes and productivity. Suppliers can offer off-the-shelf drives ranging from small, low voltage (LV) units to multi-megawatt, medium voltage (MV) products, as well as customised solutions where necessary.

Taking an holistic approach

Conserving energy is always good for business profitability. When the energy saved would have been generated by burning fossil fuels, there is a consequent planet-friendly reduction in CO_2 emissions and carbon footprint. It also makes sense to make the most efficient use of energy, even when the needs of an industrial plant can be met entirely from renewable resources. Because more green energy is then available to other users, so less generation from fossil fuels is needed elsewhere. On top of its climate-related benefits, this also lowers the levels of harmful airborne sulphur and nitrogen oxides, particulates and other pollutants.

Another holistic consideration relevant to electric equipment is that anything which extends its lifetime – such as applying VSDs – reduces energy expenditure and emissions associated with manufacturing replacements. An additional commercial bonus is that all of these gains can contribute positively to a company's environmentally friendly image, corporate social responsibility credentials and public relations.

Improving energy efficiency is one of the main sustainability issues and trends which will help reduce this industry's CO_2 emissions, environmental impacts and climate effects. Some others include: switching to renewable energy sources, like solar and wind; moving from coal to hydrogen; and capture, reuse and storage of carbon. Since CO_2 emissions are now becoming tradeable, there may even be possibilities to open up new revenue streams through carbon reduction.

Just as electric motors and drives permeate all processes and equipment in an iron or steel plant, their manufacturers have connections with every issue related to them. That is why ABB is involved in studies, projects and developments in each of the fields mentioned and is developing products and expertise to support them.

Sustainable advances

Distribution and supply of electricity generated by wind and sun requires electrification technology. Specific needs include high-power rectifiers for the powerful electric arc furnaces which will become increasingly common.

As an example of what is possible, Nucor is currently working on what will be the first steel plant in the US to run on wind energy. The micromill in Sedalia, Missouri, will be supplied with renewable electricity from sources including a new wind farm. Its electric arc furnaces will melt scrap steel, from which recycled steel rebar will be produced.

In another example, in September 2019, Xcel Energy, EVRAZ North America, and Lightsource bp announced that they had formed an innovative long-term partnership to develop the 300 MW Bighorn Solar project in Pueblo, Colorado, in order to power the EVRAZ Rocky Mountain Steel mill facility. It will be North America's first solar-powered steel mill.

Electric motors and drives maximise efficiency across all the processes involved in the HYBRIT initiative (Hydrogen Breakthrough Ironmaking Technology), in Sweden, which aims to develop the first fossil-free steel from iron ore. The processes in this or any similar operation require handling and transport of solids (including ores and steel), liquids (including water) and gases (including hydrogen).

ABB's support in relation to capturing, reusing and storing carbon focuses largely on provision of copper-based catalysis technology – a field in which it has many years of experience. The company also works with compressor OEMs (original equipment manufacturers) producing equipment used in liquefying CO_2.

Drives are a good place to start

The IEA's roadmap[3] says that carbon capture, reuse and storage, along with

Machine with conveyor belt with glowing metal frame in the production line of a steel mill

replacement of coal by hydrogen, will be vital for further decarbonisation beyond 2030. However, in the meantime it expects improvements in technology's performance and efficiency to deliver 90% of annual CO_2 emission reductions. Motorised equipment and systems are ideal targets for such improvement, especially if they are not currently being controlled by variable speed drives (VSDs) or if they are technologically outdated.

There are numerous applications in which motors are either run constantly at their maximum speed or regulated by mechanisms which provide little control and precision. A good example is the baghouse fans which draw in contaminated air from production processes to filter out metal dust. This is an especially energy-hungry application. One of ABB's US customers estimates that 98% of baghouse fans are not operated by a drive. These and other quadratic load applications, such as the fans and pumps found throughout iron and steel plants, may offer the greatest potential for energy savings.

Co-operation is essential

When assembling something like a baghouse fan as a complete system, any turnkey supplier might consider the use of a low-cost mechanical flow control device, unless the use of a VSD is specified. Not using a VSD will keep the package price down, but adds ongoing costs through operational inefficiency. ABB works with OEMs to ensure the optimum motor and drive combination. In a recent illustration of such co-operation, the company worked with an iron and steel production machinery manufacturer on a project for a US-based steelmaker. ABB supplied an optimised package of motors, drives and ancillary equipment for mills, coilers, edgers and descaling pumps which will be used in a state-of-the-art steel plate mill. Similarly, the company collaborates with engineering, procurement and construction (EPC) and other consulting partners to achieve the best results from projects.

ABB also works with iron and steel producers to assess existing installations and recommend improvements. This gives specialists a chance to discuss issues on-site and demonstrate the value of VSD solutions to engineering and maintenance managers. Retrofitting of VSDs where no existing motor control is present, or to replace inefficient mechanical controls or upgrade older drives, is relatively straightforward. The latest VSD technology offers a high degree of flexibility to allow effective integration with legacy equipment and easy adaptation to changes in processes.

An important development across the whole of manufacturing industry is the introduction of the latest EU (European Union) energy-efficiency-promoting legislation (Eco Directive) that sets new minimum efficiency criteria for low voltage motors used inside the EU.

Furthermore, Eco-directive-compliant motors, combined with the latest VFDs and smart sensors, provide not only improved energy-efficiency, but also savings in maintenance through the capability for remote, condition-based preventive maintenance regimes.

Although today's sustainability crisis may seem daunting, the technological ingenuity already evident in the iron and steel industry promises an exciting transformation to an energy-efficient future. Adopting high-efficiency motors operated by drives will be a key element in the process. ■

1. Downloadable at https://new.abb.com/metals/future
2. Downloadable at https://www.energy-transitions.org/publications/mission-possible-sectoral-focus-steel/
3. Downloadable at https://webstore.iea.org/iron-and-steel-technology-roadmap
4. Downloadable at https://www.researchgate.net/publication/241972048_Energy_Efficiency_Improvement_and_Cost_Saving_Opportunities_for_the_US_Iron_and_Steel_Industry_An_ENERGY_STARR_Guide_for_Energy_and_Plant_Managers