techmag

EFFICIENT HEATING TECHNOLOGY FOR THE ENERGY REVOLUTION

Saving energy by heating homes with heat pumps, gas condensing technology, or hybrid systems

FREE-RANGE MOBILITY IN AUTOMATED GUIDED VEHICLES

Breaking open the pearl chain

THE RIGHT SOLUTION FOR EVERY INSTALLATION SITUATION

Interaction between fan and application

GREATER EFFICIENCY AND FLEXIBILITY UNDER THE HOOD

EC blowers for range hoods

New EC centrifugal fan for greater power and efficiency

New impeller geometry and high-performance electronics provide improved, quieter operation

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Uwe Sigloch

DIRECTOR OF
PRODUCT MANAGEMENT
EBM-PAPST MULFINGEN

“Aim high, touch the sky”

Dear Customers, Partners and Friends of ebm-papst,

Higher, faster, further — this idea has shaped sporting competition for centuries and captured people’s imagination. The major requirements of our industry can also be summed up in three words. Here, the aim is to be more efficient, more quiet, and more intelligent. The reasons for these ever-increasing demands range from growing awareness of sustainability to high competitive pressure and tougher legal regulations. It's good that the requirements are increasing. Just as an athlete becomes stronger with each new goal, new demands in technology also foster a spirit of engineering and creativity for ever better solutions.

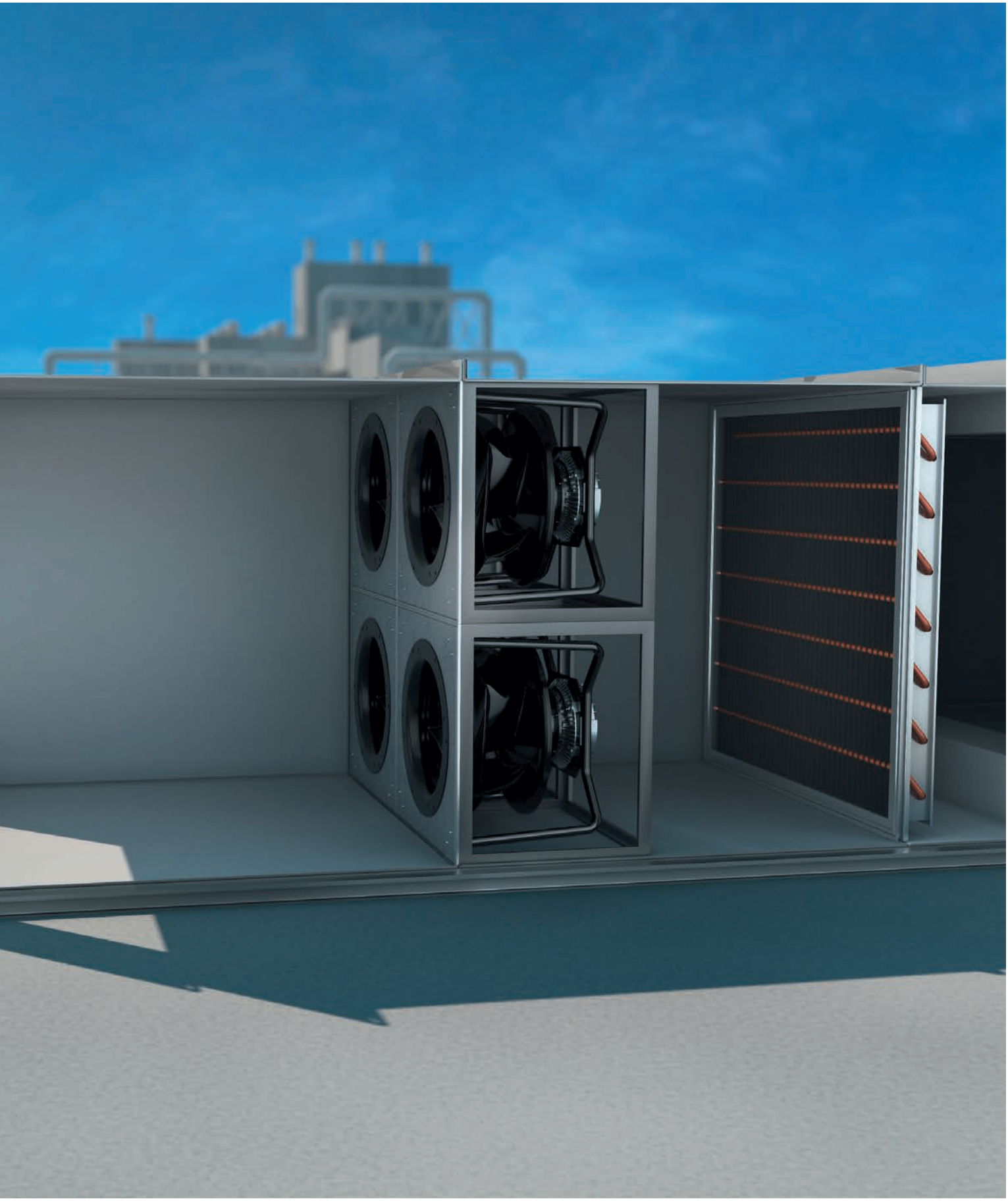
Our new centrifugal fan from the RadiPac product range is a good example of this. The fan masters the three disciplines of efficiency, low volume and intelligence with particular aplomb. Its high efficiency is reflected in lower operating costs, and it protects the environment due to fewer CO_2emissions during operation. The RadiPac’s low noise level is beneficial to the well-being of those around it and its built-in intelligence enables operating data and conditions to be reported to its surroundings. Thanks to a sensor installed as standard, it also detects harmful vibrations, among other things, and reports them immediately. This allows users to respond to problems at an earlier stage and with greater focus, thereby ensuring smooth operation. This bundle of features makes the RadiPac the latest winner in our product portfolio.

Would you like to find out more about technical excellence? Then read the article about RadiPac and the other exciting topics in this issue!

New impeller geometry and high-performance electronics provide improved, quieter operation

New EC centrifugal fan for greater power and efficiency

Ventilation and air-conditioning fans are constantly being refined, as users' requirements are increasing rapidly – especially when it comes to control options and energy efficiency. Legal requirements, increasing environmental awareness, and potential savings when it comes to operating costs are all playing a role in this trend. Centrifugal fans from ebm-papst set new standards here: Thanks to aerodynamic optimizations, innovative materials, sophisticated design details, and highly efficient EC motors with intelligent control electronics, they not only deliver significantly more air performance than before, but they are also particularly quiet and efficient. This is advantageous for both ventilation and air-conditioning technology, as well as industrial applications.



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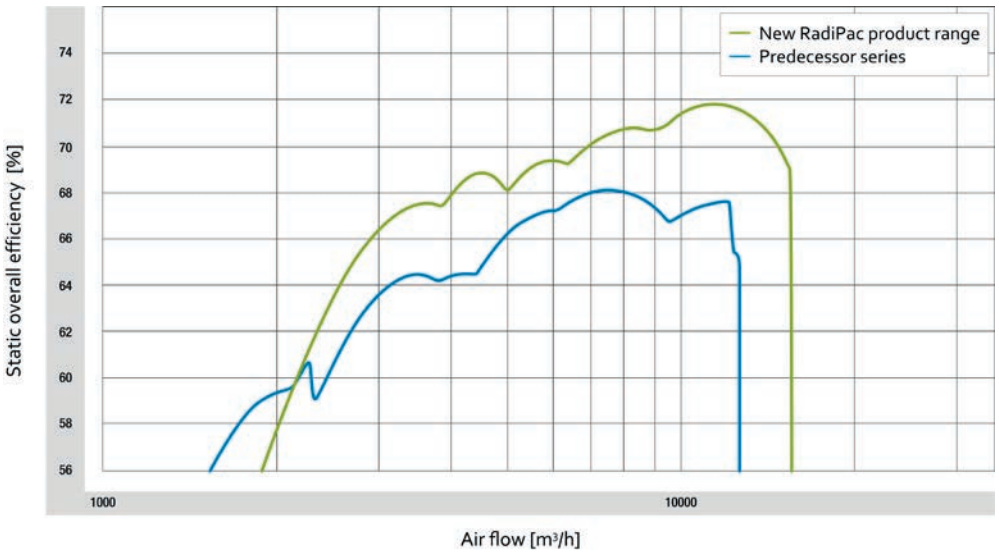

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FIGURE 1: **The new RadiPac: The new generation of centrifugal fans offers higher efficiency; this results in significantly lower operating costs.**

For some time now, motor and fan specialist ebmpapst has been employing a continuous improvement process in fan technology. In recent years, the centrifugal fans in the RadiPac series specially designed for use in air conditioning and ventilation units have been constantly optimized, with particular emphasis on energy efficiency, noise reduction, and handling. With the new RadiPac, it has been possible to make another decisive improvement in this successful series. The new-generation centrifugal fans work with higher efficiency levels (Fig. 1). Higher speeds ensure a higher air flow and higher pressures, meaning that even high-pressure applications can be covered (Fig. 2). The static pressure increase that can be achieved is well over 2,000 Pa. In addition, noise generation has decreased further; depending on the operating point, the noise level is reduced by between 3 and 7 dB(A) compared to the predecessor series.

Impeller: High-strength composite material, plus innovative geometry

To bring about this optimization, the impeller plays an important role. It has been developed according to the latest aerodynamic findings with its five geometrically sophisticated impeller blades (Fig. 3). A high-strength, glass-fiber reinforced composite material is used here. The complex shape is made possible by the injection molding process used. This blade geometry drastically reduces flow losses. The rounded flow contour at the blade inlet and the blade trailing edge, which tapers toward the back, contribute to this. The wavy cover plate leads to an optimal air flow rate through the impeller. The inlet ring is also made of composite material and is designed for perfect interaction with the new impeller.

The sophisticated impeller geometry not only reduces flow losses, but also noise generation. When it comes to

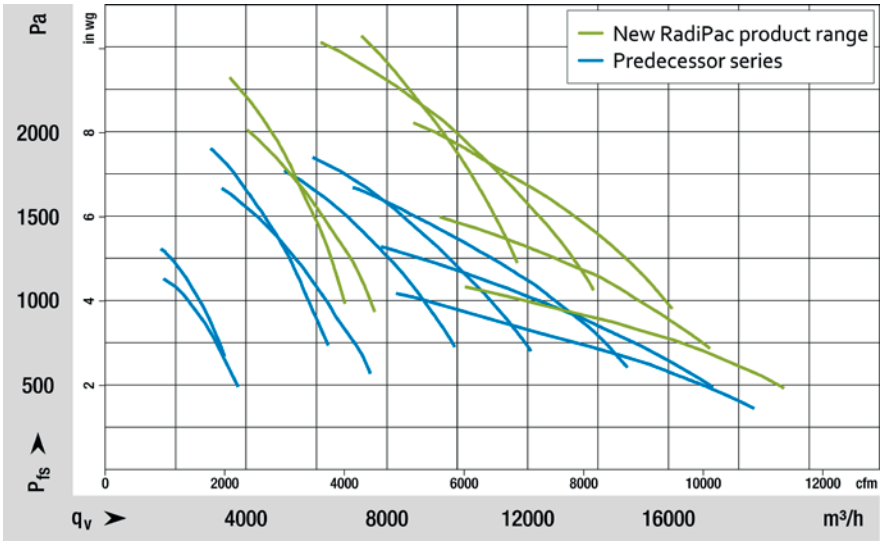

FIGURE 2: **Increase in power density in the new RadiPac compared to the predecessor series.**

its strength, the mechanical design of the impeller also impresses. The edges on the intake and outlet sides are counter-curved, which increases the impeller's stability. High peripheral speeds are therefore easily possible and, depending on the impeller diameter, they result in correspondingly high speeds. This has been proven under harsh conditions in extensive stress and long-term tests. They can be operated at maximum speed in a temperature range from -25°C to +40°C. Here, the tried-and-tested industrial composite material meets all the relevant standards, and UL approval is also available if required.

GreenTech EC motors: Stronger, more flexible, and even more compact

The driving force behind the new RadiPac centrifugal fans are high-efficiency GreenTech EC motors in the power range from 500 W to 8 kW. The integrated EC motors with external rotor design achieve efficiency levels in accordance with the requirements for efficiency class IE5 set out in IEC/TS 60034-30-2. For reasons of system effi-

FIGURE 3: **The material used is a high-strength, glass fiber-reinforced composite material. The injection molding process enables a complex shape.**

ciency, the drive system consisting of motor and integrated power electronics is individually adapted on each fan, and is optimized for the respective operating range. The newly developed 8 kW drive sets new standards. The performance of the integrated electronics has been increased again, even with its more compact dimensions. This makes the drive the most powerful in its class at present. Design and functionality have also been updated to the latest generation, and upgraded to include a configurable interface – including the MODBUS-RTU interface and integrated resonance sensor (see text in box). This resonance sensor measures oscillations and vibrations in real time. It can therefore detect imbalance due to dirt, for example, and then transmit a message before the fan is damaged – in keeping with the GreenIntelligence philosophy.

Numerous flexible options

To meet the requirements of different installation situations, the new centrifugal fans are available in a standard and short version (Fig. 4). With the most powerful standard types, the impeller is attached to the motor in such a way that it has no negative influence on aerodynamic efficiency. In the short version, the motor is immersed in the impeller. These fans are more compact and are much more efficient than comparable predecessor models in spite of the slightly shorter axial installation dimensions in comparison to the standard version.

Both RadiPac versions are available as a motor-impeller combination or as a ready-to-install plug & play solution in a compact support bracket for easy wall mounting (Fig. 5). The support plates have been dimensioned to make the best possible use of space on a Euro pallet, thereby saving transport costs and improving the CO_2 footprint. A completely enclosed FlowGrid air inlet grill is also available as an option. This acts as a kind of rectifier that reduces noise-generating turbulence in the inflow without changing the air performance and power consumption. It also serves as a guard grill for the intake side. The fans are then even quieter, which benefits ventilation applications as well as many others.

The new-generation centrifugal fans work with higher efficiency levels.

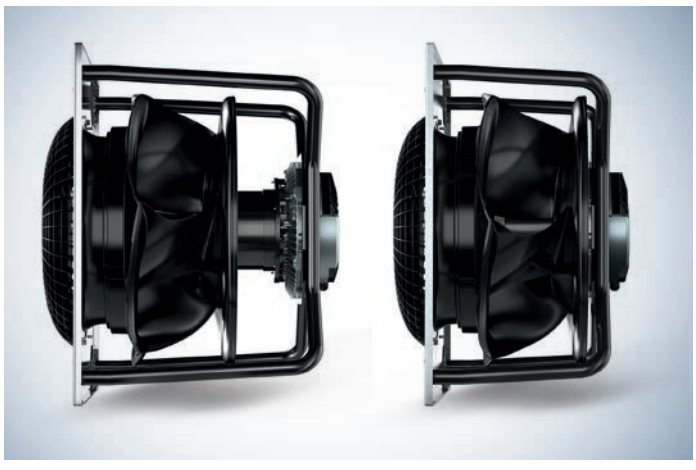

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FIGURE 4: **In the standard types (left), the powerful motor is completely pulled out of the flow area. In the short version (right), the motor is immersed in the impeller.**

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FIGURE 5: **The new RadiPac as a ready-to-install plug & play solution in a compact support bracket for easy wall mounting.**

Fitting dimensions – suitable for a retrofit

Retrofitting is normally possible without design modifications in the application, as the new fans are geometrically smaller when it comes to the same model size despite their higher performance. From October 2021, the new centrifugal fans will be available in model sizes 310 to 630 with air performances of up to 20,000 m^3/h and a static pressure increase to over 2,000 Pa. Samples are available with immediate effect upon request.

In the next step, there will also be FanGrid variants in the series. This cubic housing allows several fans to be arranged next to or on top of each other to make the best use of the available installation space. With this development, ebm-papst is showing that there are always new approaches to significantly improving energy efficiency, air performance, and noise generation.

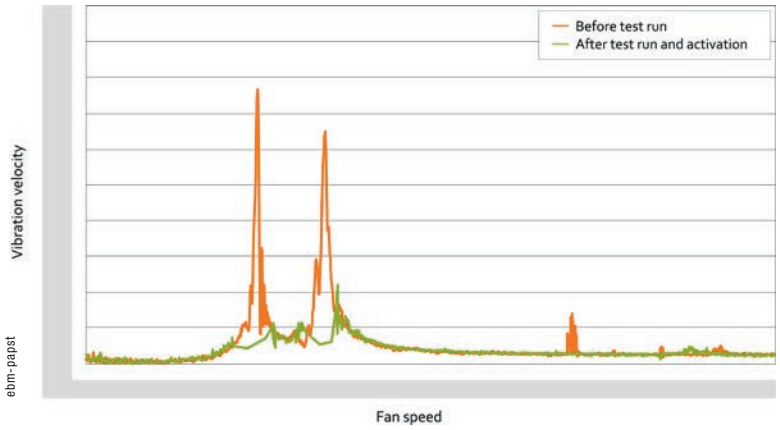

FIGURE 6: **If standard resonance detection is activated, ranges with excessive vibration velocities are detected and "overrun".**

AUTOMATIC RESONANCE DETECTION FOR MORE OPERATING RELIABILITY

Centrifugal fans are used in a wide range of applications. Depending on the installation situation, there may be resonance in unforeseen speed ranges. If the fan is often operated in such critical ranges, the drive motors' bearing system may be damaged, leading to fan failure. For system operators, these vibrations can be measured but are not easy to suppress. In its RadiPac centrifugal fans, ebm-papst solves the problem with an automatic resonance detection function that minimizes the effect of vibrations. A test start-up is carried out during commissioning in which the vibration levels over the entire speed curve are recorded and analyzed. If excessive vibration velocities are detected in specific ranges, the control software automatically sets itself to "fast-forward" through these speed ranges in the future (see Fig. 6). In this way EC centrifugal fans can be operated without risk of damage. Operators can manually edit the software settings at any time and always have full control.

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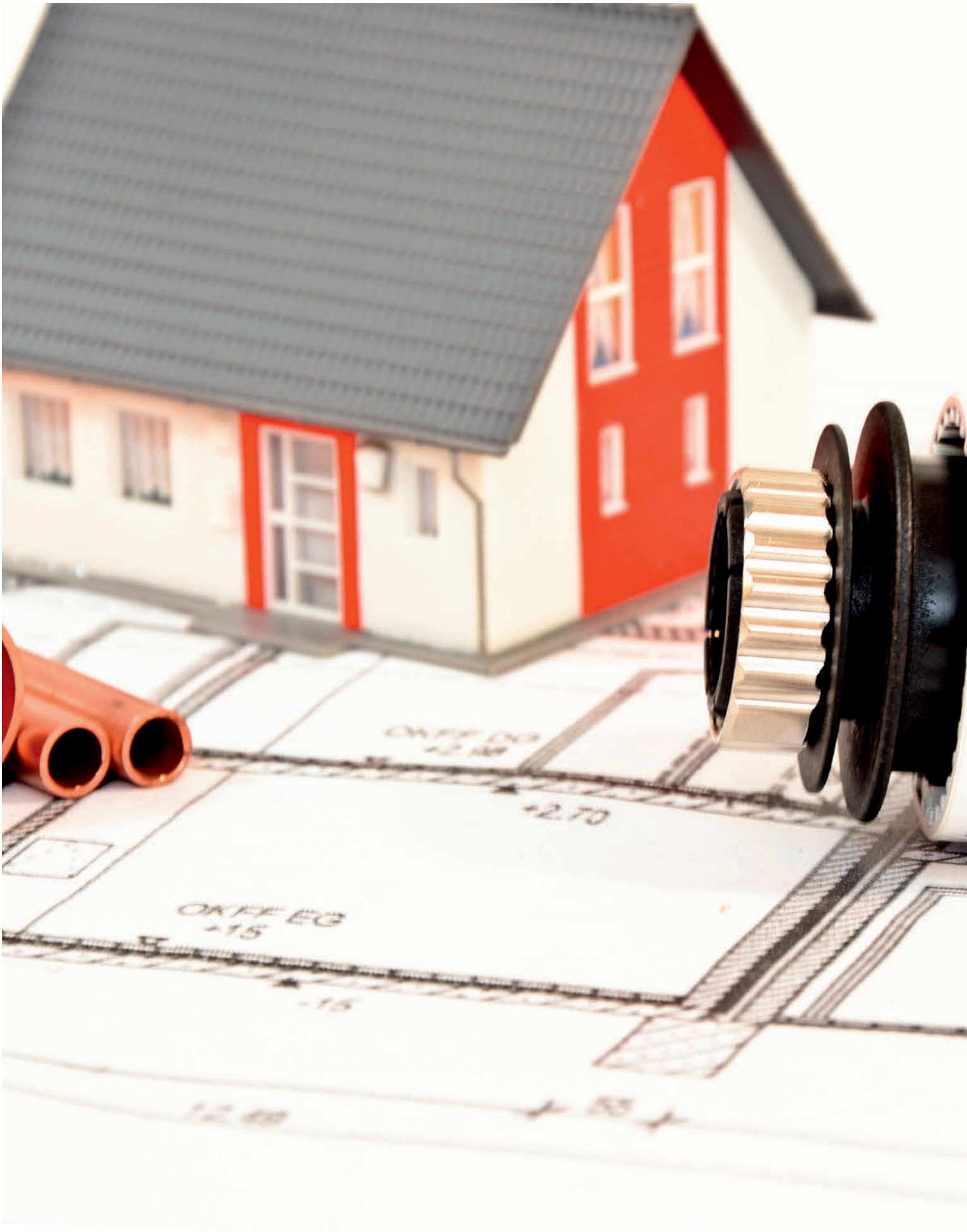

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Saving energy by heating homes with heat pumps, gas condensing technology, or hybrid systems

Efficient heating technology for the energy revolution

The EU's main objective is to reach net zero emissions by 2050. But to achieve this, a heating revolution in addition to the energy revolution is required. Heating our homes using heat pumps, gas condensing technology, or hybrid systems would cut down on emissions and also save money. ebm-papst makes system components that meet the stringent efficiency requirements demanded of state-of-the-art heating applications, and thus provide optimum operation and climate protection.

Switching from fossil fuels to renewable energy sets us on the right course for a net zero emissions future. Making our heating technology more efficient in this respect is vital to be able to accelerate the energy revolution. There is vast potential for improvement in this area: around 40% of the final energy consumed in Germany is in buildings. And around 85% of this is used for building heating and domestic hot water . There is a substantial need to modernize existing heating systems on a national scale: millions of heating systems in Germany are more than 15 years old and their energy efficiency lags far behind the latest technology. However, all that is set to change: state-of-the-art heating systems like heat pumps, gas condensing boilers, or hybrid heating systems are the technologies of the hour for both new builds and renovations of existing buildings. Thanks to its highly efficient system components and optimal solutions for any application, ebm-papst is helping to shape the energy and heating revolution.

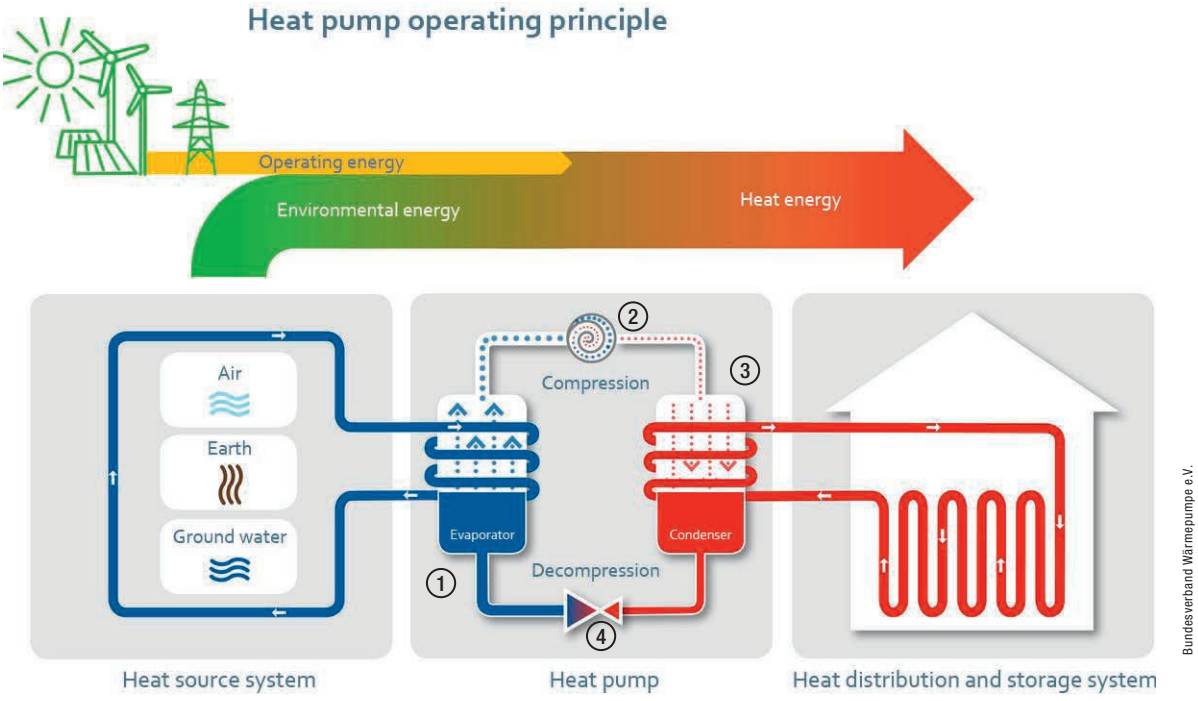

FIGURE 1: **The heat obtained from water, earth, or air is transferred to a liquid refrigerant. This is carried out by means of a heat exchanger – the evaporator (1). For this process, the refrigerant must be colder than ground water, soil, or air. This causes the cooler refrigerant to evaporate due to the heat. An electric compressor compresses the gaseous refrigerant (2). This compression causes the refrigerant to heat up significantly. A second heat exchanger (the condenser) emits this heat to the heating system and to the optional hot water tank. The gaseous refrigerant (3) condenses again. It returns to the evaporator via the expansion valve, and the cycle described is repeated (4).**

The new AxiEco series is the perfect partner for modern heat pumps.

Energy from the environment

In the search for sustainable heat generation, the choice is increasingly being made to use heat pumps, and it is projected that 48 to 60 million heat pumps will be installed in buildings throughout the EU by 2030. A heat pump works by extracting energy from its environment, i.e. from water, air, or earth (Fig. 1). In an ideal case, it would also be powered by renewable energy, such as solar energy captured by a photovoltaic system. This makes heat pumps independent of rising electricity prices and lowers operating costs. They can also be run in reverse and used for cooling buildings in the summer. Another important advantage of heat pumps in terms of climate protection is that, as they are powered by renewable energy, they do not generate any CO_2.

RadiCal on the inside, AxiEco on the outside

Air-water heat pumps require fans that are specifically adapted to the application. Not only do they have to work at optimum efficiency and at low noise levels, but also have to be intelligently networked. In indoor installations, the heat pump draws in the outside air through a duct and blows the exhaust air out again via another duct. This results in pressure losses. State-of-the-art RadiCal centrifugal fans from ebm-papst are extremely well suited for this type of application, as they enable a high pressure increase, minimize energy consumption and noise, and exceed the applicable legal requirements of the ErP Efficiency Directive.

In outdoor installations on the other hand, the ambient air is drawn in directly by the device, and noise generation is a particularly key consideration. Axial fans are especially well suited in this respect, as they operate at constant low speeds and thus at low noise levels. The new AxiEco series (Fig. 2) from ebm-papst is the perfect partner for modern heat pumps, as the optimum flow rate of these fans and low noise emissions make them ideal for applications in noise-sensitive areas. This series of fans is also very effective at preventing the formation of ice on the evaporator, and they come with a MODBUS-RTU interface, which opens up several options for predictive maintenance. It's GreenIntelligence through and through. The fans are future-proof in design, as they are also suitable for the use of natural refrigerants such as flammable propane.

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FIGURE 2: **The new AxiEco Perform EC axial fan from the AxiEco series in the application example of an air/water heat pump.**

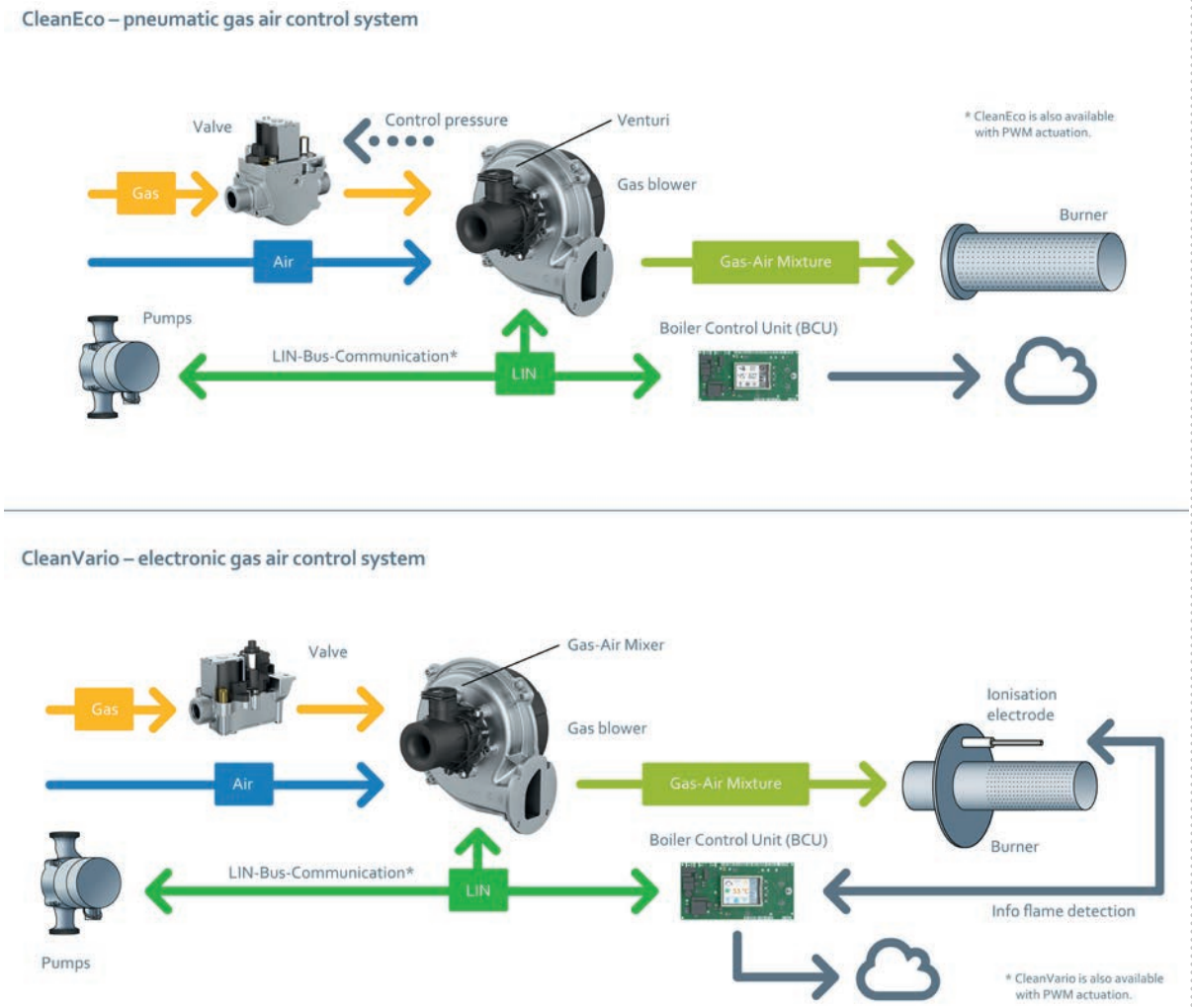

FIGURE 3: **CleanEco pneumatic combustion control (top) and CleanVario electronic combustion control (bottom) offer a perfectly coordinated complete system consisting of a boiler control unit (BCU), gas valve, Venturi and gas blower.**

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The CleanVario system can be adapted from gas to potential future alternative fuel types.

"Renewable ready" gas condensing technology

Modern gas condensing boilers are not just compact and inexpensive, they can also effectively scale their heating output. And as well as using gas to produce heat, they use the latent heat from the water vapor that is produced by the combustion process and is contained within the exhaust gas. Cooling the exhaust gas temperature in this manner increases efficiency by up to 15% compared to conventional systems. So in turn, less fuel is required. This is currently the most important bridging technology in the energy revolution – simply by replacing old heating systems with gas condensing technology and achieving the associated CO_2 reduction. But the consumption of fossil fuels can be reduced even further, as gas condensing technology is "renewable ready", and can be combined at a later point with renewable energy sources. For example, if combined with solar heating, it can heat the water used in the summer, or when combined with a living-room pellet stove with integrated water tank, it can function as a heat source in the winter.

Clean combustion from a single source

Modern condensing boilers are controlled electronically and adapt the heating output very flexibly to the required heating load. As a result, all of the components installed within this type of boiler should be able to cope with the wide heating output range, as this increases the efficiency of the entire unit. The CleanEco (pneumatic) and CleanVario (electronic) combustion control types provide a perfectly coordinated complete system consisting of a boiler control unit (BCU), gas valve, Venturi and gas blower (Fig. 3). Regardless of whether the gas valve is controlled using a vacuum (CleanEco) or electronic actuation of the gas valve (CleanVario), both systems always produce an optimum, stable mixture of oxygen and fuel. Modulation levels of 1:10 are now possible – and thus very environmentally friendly operation. ebm-papst has even future-proofed the design: the CleanVario system can be adapted from gas to potential future alternative fuel types, such as hydrogen admixtures with hydrogen from power-to-gas systems, liquid gas, or biomethane, and can guarantee a constant output with an efficiency of at least 93% despite increased fluctuations.

The best of both worlds

Hybrid systems consisting of a gas condensing unit and a heat pump are particularly useful if the gas power is required in booster mode (water heating) or at very low outside temperatures. So what's the advantage? The heat pump is responsible for the heating base load; if the outdoor temperatures drop significantly into the sub-zero range, the gas condensing boiler works as a booster. This guarantees constant heat in all seasons. To avoid using fossil fuels

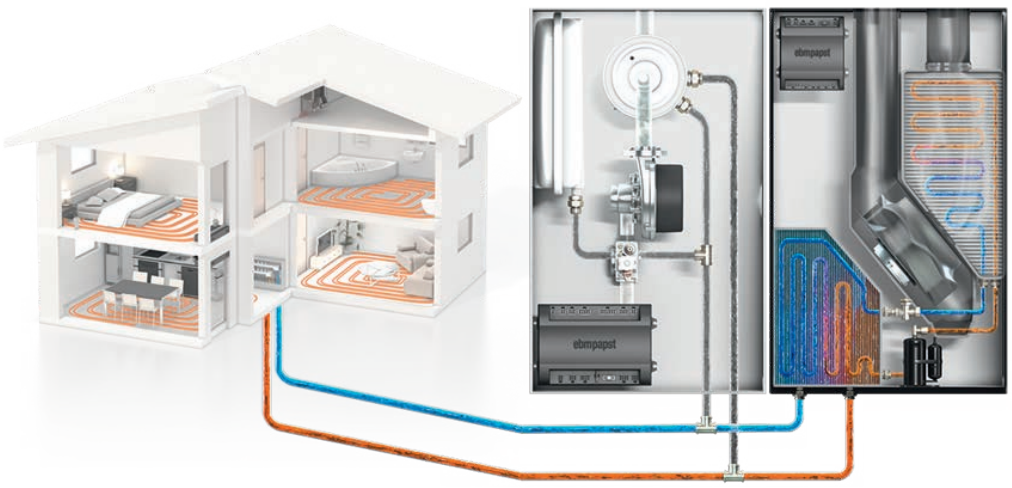

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FIGURE 4: **The 900H Series Control Platform from ebm-papst adapts the output of the hybrid system according to the situation, and controls the connection of the condensing boiler when temperatures drop below zero.**

as much as possible, customers can control the point at which gas condensing technology jumps in, and thus also select the cheapest operating mode based on the electricity/gas prices. This makes the hybrid system the perfect combination of renewable energy and efficiency and a future-proof solution, as it works independently of a single power source.

An intelligent higher-level control system is the linchpin that ensures a consistent supply of cosy heat: the 900H Series Control Platform from ebm-papst. It adapts the output of the gas condens-ing unit and the heat pump according to the situation, and controls the connection or sole opera-tion of the condensing boiler during peaks (Fig 4). An intuitive user interface makes the temper-ature of the room and hot water convenient to control. The CleanVario electronic combustion system constantly monitors combustion and can realize the possibilities of predictive mainte-nance thanks to the LIN bus capability of the gas blower.

The matter of funding

As well as the technology itself gaining momentum, state grants are increasingly being offered in an attempt to provide more incentives to invest in sustainable heating technology: Germany has around six billion euros of funding available for 2021. For example, the German state-owned investment and development bank KfW has launched a new funding program offering subsidies for the construction of or first-time acquisition of energy-efficient homes (according to criteria

set out by the KfW). The subsidy amount is based on the energy-efficiency level of the building: a maximum of 25% for a new build with an efficiency of 40+, and 40% (maximum of 48,000 euros per residential unit) for a renovation with an efficiency of 55. The funding pro-grams offered by the German Federal Office for Economic Affairs and Export Control (BAFA) for existing buildings also have attractive conditions: the replacement of a gas-condensing heating system to one that is "renewable ready" is subsidized at 20%, and the acquisition of a heat pump or gas hybrid heating system at 35% to 45% and 30% to 40% respectively. More information on this can be found in the brochure "Moderne Heizungstechnik mit Geld vom Staat" (Modern heating technology subsidized by the state) – March 2021 issue of Bundesverband der deutschen Heizungsindustrie (BDH – Federation of German Heating Industry). But Germany isn't the only country that offers funding programs. In Italy and South Korea for example, the generous subsidies provided by the state demonstrate how much of a focus there is on switching to state-of-the-art, sustainable heating technology. ○

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Breaking open the pearl chain

Free-range mobility in Automated Guided Vehicles

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Batch sizes are becoming smaller, product life cycles are shorter, rigid conveyor belts and inflexible production lines are giving way to modular concepts. In addition, manufacturing and storage areas are expensive and optimizing space saves costs. Quick, flexible and reliable material flow concepts are required to implement this – using freely navigable Automated Guided Vehicles (AGV). Omnidirectional mobility is a key feature of transport solutions.

AGVs have been in use for a long time in many warehouses, distribution centers and manufacturing facilities. They are used to transport material in containers or on pallets, without requiring a physical transport network. Yet, if you look around many halls, the AGVs move in a rigid and inflexible way, running along the line markings made on the floor. So long as rigid production lines are being set up, particularly in manufacturing, there is an elegant material supply solution using track-guided solutions. If the products to be manufactured go through the machines like a pearl chain, from one processing step to the next without variance, the flow of material does not require any changes.

Track-guided solutions have advantages, such as a low level of complexity and comparably simple safety technology, but their flexibility is very limited. The AGVs can only stop if they reach obstacles: they cannot drive around them. However, the far greater disadvantage in modern manufacturing scenarios is that selectively approaching production stations and implementing automatic route changes is not possible. Route changes require new line markings on the floor: it is not possible to simply reconfigure them using software. This means that track-guided solutions in modern manufacturing and intralogistics concepts are no longer keeping pace with the times, because the increasing number of assemblies with a modular set-up for high product variance require new concepts to keep goods flowing. In addition to a flexible flow of materials, mobile machines are also an important factor. For example, AGVs automatically transport the robot mounted onto them to the next workstation.

AGVs that can navigate completely freely and offer unrestricted free-range mobility are necessary for implementing modern manufacturing concepts and optimizing intralogistics processes. Of course, controlling and navigating vehicles with free-range mobility is more complex. There are greater requirements for sensors and safety technology, but sophisticated solutions already exist. Below, read why extensive free-range mobility with omnidirectional freedom of movement in AGVs enables greater efficiency in logistics and production.

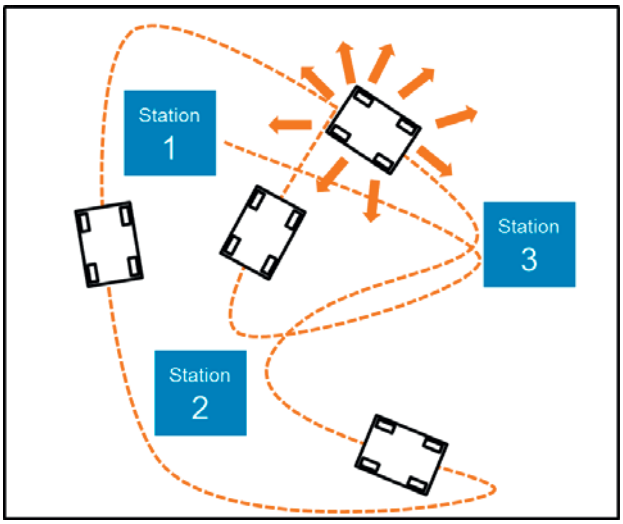

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FIGURE 1: **Modern production concepts require AGVs that can navigate completely freely and offer unrestricted free-range mobility.**

Reduce space requirements and the associated costs

On the one hand, space in warehouses and manufacturing facilities comes at a high fixed cost. On the other hand, it soon becomes difficult to find space to carry out all of the necessary activities, particularly if there is a growing volume of orders. Therefore, making optimum use of space provides an important contribution to the Overall Equipment Effectiveness (OEE) in existing buildings and manufacturing areas as well as in new designs. For track-guided AGVs in particular, a lot of space has to be reserved for the routes. Limited maneuverability means that a lot of surface area is required to accommodate the bends and load transfer points. In principle, these AGVs can be compared with passenger cars, as these too have a limited freedom of movement. For example, it is not possible for them to turn when stationary or to move sideways. In addition, the line-marked routes must always be kept clear, including a safety zone. It is not possible to place temporary structures or to store materials and machines there. Flexibility in the layout of logistics and manufacturing areas remains restricted.

However, using freely navigable AGVs with drive solutions for free-range travel means that a lot less space is required for cornering and maneuvering at material transfer points. Omnidirectional systems with complete free-range mobility enable all travel manoeuvres. These include moving transverse to the direction of travel, turning when stationary and many combinations of movements. Even in very confined environments, the AGVs can carry out exact manoeuvres with omnidirectional motion. In principle, their maneuverability is comparable with a hovercraft: the orientation of the transport frame is independent from the direction and position of travel.

Enabling modular production

AGVs' free-range mobility not only saves space. The free navigation also reduces the distances that need to be traveled and simplifies driving around sudden or temporary obsta-

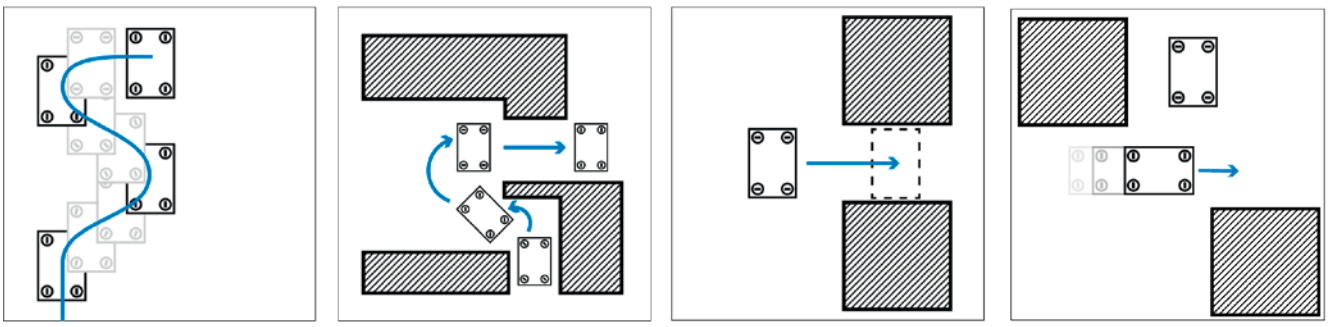

FIGURE 2: **With the ArgoDrive driving/steering system from ebm-papst, AGVs navigate freely and omnidirectionally over the entire area, drive around unexpected obstacles and move easily even in very tight environments.**

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cles. This increases the dynamics and speed and, therefore, the material throughput. Furthermore, the AGVs' free-range mobility makes it possible to implement future-oriented and modular productions for the first time.

Due to the smaller batch sizes and constantly increasing product variance, rigid conveyor belts and inflexible production lines are increasingly becoming a thing of the past. The future of production means flexible manufacturing down to a batch size of one. In this context, both machines and entire production lines have to be quickly converted using modularization. This also requires flexible material transport, both to the machine and to the next machine. Mobile robotics is also being increasingly implemented in modular manufacturing systems.

Application scenarios for extensive free-range mobility

These scenarios can no longer be achieved with track-guided AGVs. The vehicle solutions have to be moved freely to the next workstation via sensors, which is implemented using a higher-level localization and control system. This control system knows exactly when and where which processing station has to be approached by which AGV with which goods and assigns the appropriate travel orders.

Since the layout of the space in modern manufacturing scenarios changes often and every angle is utilized, the AGVs must be extremely maneuverable and offer omnidirectional mobility to reach their destination quickly and safely even in very tight environments. The AGV also has to guarantee quick and safe braking using its drive technology if there are unexpected obstacles. Driving on different floor coverings and overcoming gradients are other demands placed on the drive technology to allow greater flexibility in manufacturing and the associated intralogistics.

Although the floors at manufacturing sites and logistics centers are typically made of smooth, cement-bonded industrial screed with an acrylate-based primer, halls often have strong expansion joints, rough sections and different coverings. In addition, AGVs also have to travel back and forth between halls, for example to get material from the warehouse. When doing so, the AGV has to travel over tarred surfaces and often overcome inclines at crossovers. Drive solutions

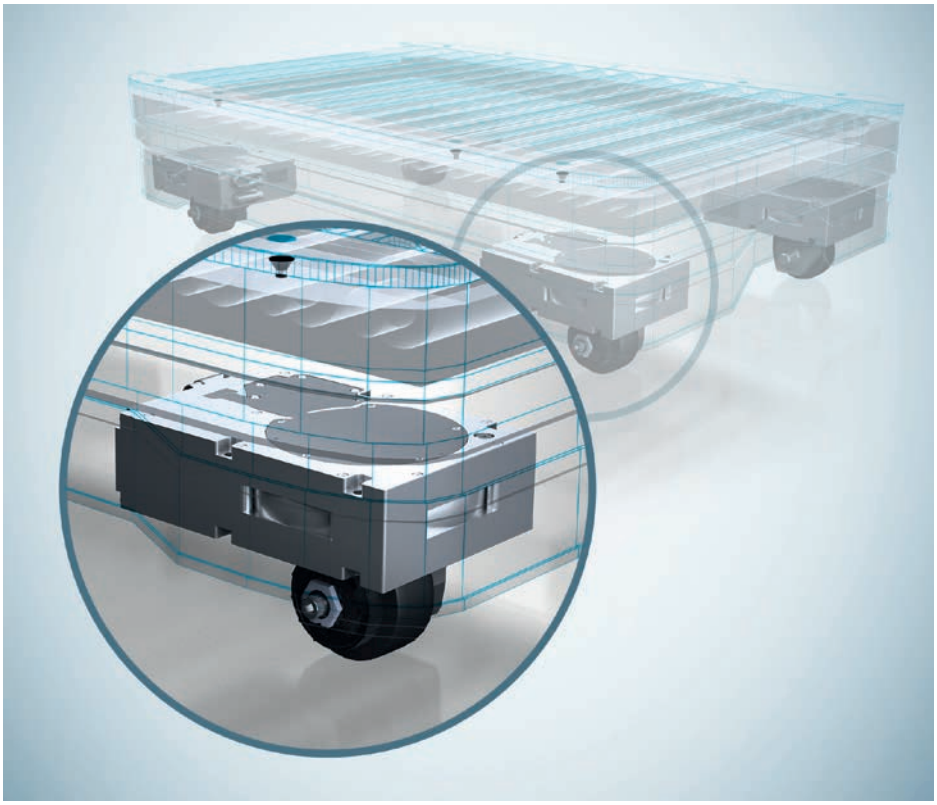

FIGURE 3: **A new drive solution for AGVs with free-range mobility: The ArgoDrive driving/steering system from ebm-papst.**

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with high maneuverability, such as the Mecanum wheel, quickly run into problems here, because they require smooth ground to move. However, this restriction is not necessary, as there are driving/steering systems that meet all the requirements of future-proof AGVs.

Fine positioning for high precision

The omnidirectional mobility of AGVs, facilitated by modern driving/steering systems, is also required for fine positioning at the machine and at material transfer stations. Here, precise adjustment down to the millimeter is required to enable containers to be moved into the workstation, for example. Equipped with high-resolution sensors and low-backlash mechanics, an omnidirectional driving/steering system positions every AGV quickly and efficiently with maximum precision.

However, the majority of current mobile AGVs have a chassis concept with three wheels, in which only one – like a classic forklift concept – ensures steering movement. Differential solutions are also widespread: in this chassis concept, the AGV can rotate around its own axis but does not perform transversal movements. Precise positioning requires time-consuming repeated forward and backward movements with additional steering or rotational movements: this also requires additional space. Drive concepts for vehicles with omnidirectional motion, such as pivoted bogies or Mecanum, once again have special requirements for the floor condition, are slow and have a high level of complexity.

Efficient implementation of free-range mobility

A new drive solution for AGVs with free-range mobility is the Argo Drive driving/steering system from ebm-papst. It combines propulsion and steering functions in one assembly. This unit consists of motors, special transmissions, sensors and all the necessary connections. Its two motors contribute towards steering, acceleration, movement and braking, depending on requirements. The infinite steering angle enables space-saving, free-range vehicle movement – even from a stationary position.

Two driving/steering systems on the left and right side of the AGV guarantee full omnidirectionality. Two additional freely moving support wheels on the front and rear ensure stability. Depending on the required size of AGV and the weight of the goods to be moved, three or four driving/steering systems can also be installed. This enables large loads to be achieved even if there are inclines. ebm-papst offers its ArgoDrive driving/steering system in light, standard and heavy versions for weight classes up to 100, 300 or 500 kg in order to meet every requirement for moving masses, for braking and for mastering inclines in a scalable way. For example, four driving/steering systems in the heavy version allow a total vehicle weight of up to two metric tons.

Benefits combined in one driving/steering system

There are various chassis concepts for putting AGVs into service. How maneuverable the vehicle is in the end and how much load it can carry depends greatly on the drive and the wheels. Depending on topology, users often have to accept compromises and, for example, sacrifice maneuverability or compactness. New solutions such as the driving/steering system from ebm-papst minimize any compromises for manufacturers of future-oriented AGVs. ○

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The right solution for every installation situation

Fans are complex flow machines, which sometimes respond to aerodynamic changes in their surroundings. The installation situation plays an important role here. This means that, when installed in the application, the fan is often not as quiet as hoped for, or less efficient than promised in the data sheet. The reason for this is clear: The fan data is determined on the test stand under standardized aerodynamic laboratory conditions. The reality with the individual application cannot be represented here, but must be illustrated by measurements in the customer's unit. Customer-specific installation conditions can be simulated using software tools and can then be incorporated into the development, optimization, or selection of fans. Last but not least, we recommend having the fan manufacturer on board at an early stage of in-house unit development. This means there will certainly be no unpleasant surprises later.

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Today, modern centrifugal and axial fans are very efficient and quiet. However, once installed in an application, their behavior will change if the inflow or outflow conditions are disturbed (Fig. 1). In an air-conditioning unit, fans are ultimately a means to an end. Negative effects are therefore usually due to function. Flaps and filters can change the air flow and the distance to walls and heat exchangers, as well as the use of guard grills, have an impact. Typical selection programs (Fig. 2) can only take into account these effects to a limited extent, as they use the values determined under laboratory conditions (Fig. 3). These must ultimately be based on reproducible measurements under (undisturbed) standard conditions. In the application, however – due to the installation conditions in the respective unit – the turbulence is more or less pronounced. This turbulence leads to noise generation that is difficult to calculate under real conditions. Once installed in the unit, the documented values often do not match reality. Figure 4 (page 28) shows how energy consumption and noise change depending on the intake-side installation situation – depending on how much the housing hinders the flow, i.e. whether it is drawn in axially from the front, centrifugally from all sides, or on one side. In the worst case, this significantly increases power consumption and noise level at the same operating point.

To ensure safety, axial fans usually have to be fitted with guard grills. Here, it is important to adapt the geometry of the guard grill to the flow control in order to generate as few losses and noises as possible. Nowadays, individual acoustic effects of guard grills have a much stronger effect than a few years ago. Modern fans in themselves work so quietly that the effects caused by the guard grill can be heard more strongly. It is therefore not useful to rely only on catalog values when it comes to power consumption and noise emissions. Selection programs should therefore be configured in such a way that they request as many parameters as possible that are based on the installation situation.

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FIGURE 1: **Today, modern centrifugal and axial fans are very efficient and quiet. However, their behavior will change once installed in an application. Flaps and filters can restrict the air flow and the distance to walls and heat exchangers, as well as the use of guard grills, can have an impact.**

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FIGURE 2: **Selection programs should be configured in such a way that they request as many parameters as possible that are based on the installation situation.**

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FIGURE 3: **The data sheet specifications are determined on the test stand. These must be based on reproducible measurements under (undisturbed) standard conditions.**

Fans should be optimized in accordance with psychoacoustic criteria.

Taking the installation situation into account during development

Since interactions between the fan and the application can always occur, fan and motor specialist ebm-papst endeavors to take the subsequent installation situation – wherever possible – into account when developing a fan. Here, application expertise gained over the course of decades is incorporated, and the wide range of disciplines involved in development work closely together, starting with high-performance simulation tools and test stands, right up to the psychoacoustic testing laboratory. The latter is becoming increasing important. This is because today an air-water heat pump set up outside can annoy the neighborhood with disturbing noise, even if it may meet the German "TA" noise regulation. To be on the safe side, fans should be optimized in accordance with psychoacoustic criteria in addition to the common evaluation of the noise level.

If the subsequent installation situation is taken into account during development, this significantly improves the results, as shown in the example of RadiPac fans (Fig. 5, page 28). Here, ebm-papst not only optimized the impeller, motor, and control electronics in terms of energy efficiency and noise emissions, but also took into account the actual installation situation in AHUs. The wide optimum efficiency range of centrifugal fans means that the fans operate at practically every operating point with the lowest possible power consumption, and there are also no unpleasant surprises in terms of noise levels.

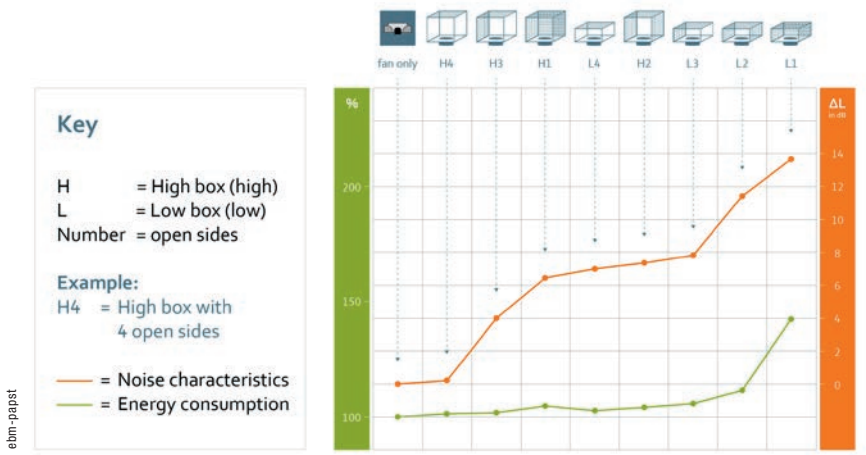

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FIGURE 4: **Energy consumption and noise change, depending on how the housing influences the flow – i.e. whether it is drawn in axially from the front, centrifugally from all sides, or on one side.**

FlowGrid improves noise level

There is a worst case for every manufacturer of an AHU: When installed, the selected fan is too loud or not efficient enough. In the worst-case scenario, market launch can be delayed by this considerably. In precisely such cases, it may be worthwhile to ask the specialists. Passive components such as the FlowGrid air-inlet grille (Fig. 6), which is suitable for axial and centrifugal fans, can also minimize unwanted effects after installation retroactively. If the fans used are retrofitted with this, this drastically reduces noise-generating turbulence in the inflow without reducing the air performance or power consumption (Fig. 7). Good results can be obtained here in noise-sensitive applications such as heat pumps, residential ventilation units and air purifiers for classrooms.

Development under real conditions

Anyone wanting to be on the safe side right from the start should involve the fan manufacturer in an early development phase of their unit. In the case of large and small fans, it is

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FIGURE 5: **With the RadiPac fans, ebm-papst not only optimized the impeller, motor, and control electronics in terms of energy efficiency and noise emissions, but also took into account the actual installation situation in AHUs.**

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FIGURE 6: **The FlowGrid is suitable for centrifugal fans (left) and axial fans (right).**

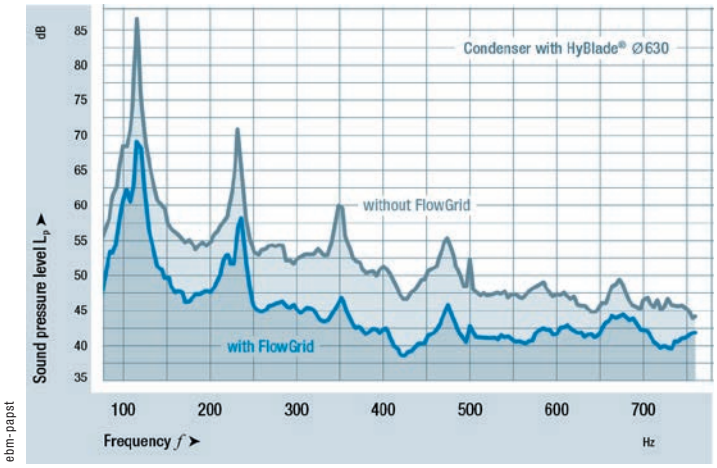

FIGURE 7: **Additional parts such as the FlowGrid can also be used to reduce unpleasant effects after installation.**

equally worthwhile to precisely analyze and evaluate the flow situation and find suitable optimization measures. As a competent partner, the fan and motor specialists at ebm-papst constantly set the standard here when air-guiding units are concerned to prevent problems in advance or to achieve the best possible noise and efficiency before product launch. ○

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EC blowers for range hoods

Greater efficiency and flexibility under the hood

EC technology is also gaining ground in range hoods. In the past, it was still a niche product for premium devices, but more stringent EU energy efficiency requirements have changed this. With the RadiFlex, ebm-papst has developed an economical, high-performance blower for a wide range of applications that can be flexibly integrated into a wide range of hood types.

Juicy meat fries in the pan, the pasta water is boiling and vegetables are stewing in the pot, but no matter how tasty the food may be, nobody likes cooking smells that stick around. Luckily, there are range hoods for this. They remove rising steam, separate grease and eliminate troublesome odors. Although the operating times of a hood are usually not particularly high, they still consume energy, and household appliances are generally supposed to be consuming much less in future. This is what the new EU energy efficiency label wants to achieve, and this will also affect range hoods. To reach a high efficiency class, manufacturers will then have to make sure that the devices meet much stricter requirements than is currently the case.

The blowers installed are a key element in increasing energy efficiency. They create the necessary induced draft to convey the kitchen fumes outwards or, if it is a recirculation unit, back into the room after the filtering process. Traditional hood manufacturers often rely on blowers with AC motors. However, this technology is quickly reaches its limits in bringing further efficiency improvements. This is not the case for blowers operated with EC motors. Their high electrical efficiency means that higher powers are even possible with lower current consumption. With extraction hoods, EC technology is nothing new. It is already established as standard in the upper mid and premium segments in particular, because these usually require higher suction power. With the more stringent specifications from the new energy label combined with increasing comfort requirements, EC technology is ideal for broad use. For example, better filter systems tend to require higher suction power on the blower side. In particular, industry requires blowers that can be used flexibly in a wide range of hood designs and installation situations. With RadiFlex, the engineers at ebm-papst have developed this type of EC blower, offering the industry the right standard.

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FIGURE 1: **The RadiFlex is compact and, thanks to EC technology, offers a high suction power.**

The pioneer for range hoods

ebm-papst built the first motor for a range hood blower back in 1963. Right up to today, this has resulted in a wide range of AC and EC centrifugal blowers for range hoods. The development of a standard blower, with its characteristic proportions and a defined installation geometry, was an important milestone around the turn of the millennium, and also turned out to be ground-breaking for the industry as a whole. The shape, dimensions, outlet diameter and connection flange of these dual flow blowers are still the preferred option on the global market to this day.

And the fan specialist is now setting the pace once again with the RadiFlex: the dual-intake centrifugal fan is not only of interest to manufacturers due to its energy efficiency but also its universal application options in a wide range of hood types.

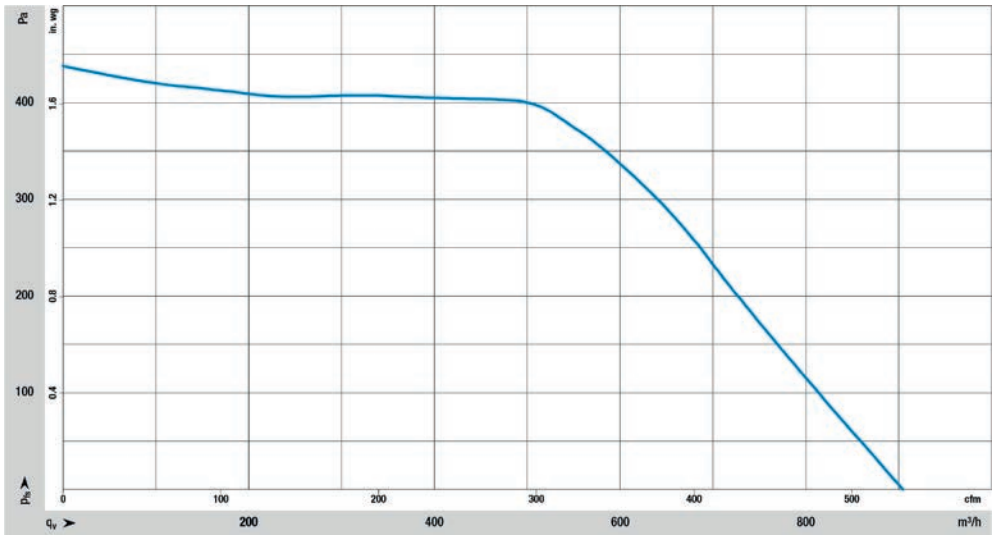

BILD 2: **Good performance: The RadiFlex can move up to 930 cubic meters of air per hour (free air).**

A question of design

Just like with food, people have different tastes when it comes to kitchen designs: almost all variations are possible, from simple built-in kitchens to large kitchens with island cooktops. And the kitchen equipment is as diverse as the range hoods (see box text 1, p. 34): a variety of types are now being used, from the simple built-in hood, T hoods, angled and vertical hoods, and extendable table extractors to downdraft extractors and island range hoods. In terms of energy efficiency, it is important to consider numerous interactions between design, function and suction power.

To keep the operation economical, it would be best to keep the suction power as low as possible, because then the current consumption is at its lowest. But it is not that simple. After all, an extraction hood not only has to dissipate air, but also deals with ambient air quality. Filters, such as close-mesh metal filters and activated carbon filters, are required for high-quality grease and odor separation. The latter can be found in air recirculation units in particular. However, the better the filter performance, the higher the associated pressure loss. A greater suction power is required in this scenario, which could be achieved very easily using a larger blower. But this brings another issue: the space is limited. Despite having a higher power, the blower cannot take up any extra space. This is because some types of hood, such as vertical hoods, cannot be integrated into larger components because of their design, and valuable storage space is also lost. This is an important thing to consider for compact kitchens. In addition, the total weight of the hood cannot just be increased at will, for example an island hood may need to be securely mounted on the ceiling. Lastly, the entire process should also be quiet. To put it in a nutshell: more suction power is required in the same space and with low noise levels. EC technology can show off all of its strengths here.

Universal use: the RadiFlex

The RadiFlex has been designed specifically for these requirements (Fig. 1, p. 32). It offers a lot of power despite its compact design and low energy consumption. The dual flow blower can convey up to 930 cubic meters of air per hour (free air) (Fig. 2, p. 33). Thanks to EC technology and a three-phase motor, it is possible to achieve high speeds without impairing the acoustics. Thanks to the high power density, the EC motor is more compact and weighs much less than a comparable AC motor: The total weight of the RadiFlex is only 1.9 kilograms, making it up to 50 percent lighter. Another advantage is that its standardized connections make it easy to install. The housing of the RadiFlex is designed so that it can be used in almost any type of hood. Protection against contact is integrated on the intake side as standard, meaning that the blower is also suitable for

A SMALL HOOD CUSTOMER

In principle, there are two different operating modes: in circulated air mode, filtered air is returned to the room, while, in exhaust air mode, the kitchen aromas escape outside. For both modes, the number of different types of range hoods is as large as the number of different kitchen designs (Fig. 3). Because of their angle of inclination, angled hoods (1) leave space above the cooktop, reducing the risk of someone hitting their head. Built-in hoods (2) are hidden in overhead structures and are particularly suitable for small kitchens. Chimney range hoods (3) are also suitable for larger cooktops. Island hoods (4) are intended for kitchen islands and are attached to the ceiling. Downdraft hoods (5) are also an option. They dissipate the kitchen fumes downward.

FIGURE 3:
The number of different types of range hoods is as large as the number of different kitchen designs.

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circulating air mode. Activated carbon filters for odor filtering can be attached at any time using the bayonet connectors on the housing. For exhaust air mode, the blower is also available with an optional non-return valve. This prevents the exhaust air from flowing back or outside air from flowing in.

EC technology offers a further advantage for closed-loop control. Depending on what is going on the stove, the hood does not always have to be turned up to full. With EC blowers, the four usual speed levels on the market can be implemented precisely using a relevant speed signal. However, the potential here has not been fully exploited. In contrast to AC technology, EC technology enables infinitely variable closed-loop control and therefore fine tuning to the actual extraction requirements.

Ready for the future

This infinitely variable closed-loop control also benefits smart functions that are increasingly in demand with range hoods. Sensors that can analyze the kitchen fumes already exist. This means that the speed of the blower can be automatically adjusted to the actual suction requirements, depending on whether steam is currently rising or something is burning. It is also possible to couple it with the cooktop. Are all ranges running at full speed? Or is only one in operation? This information could be communicated directly to the blower with the right hood control. The blower then sets itself up according to this information. The RadiFlex provides hood manufacturers with state-of-the-art and future-proof technology for broad use. ○

THE RADIFLEX – ALL THE ADVANTAGES AT A GLANCE

- Thanks to EC technology, the blower is energy efficient and quiet
- High suction power at up to 930 m^3/h
- Compact design and, at 1.9 kg, an absolute lightweight
- Integrated protection against contact and therefore also suitable for circulated air mode
- Integrated bayonet connectors enable activated carbon filters to be attached quickly and easily
- There is an optional non-return valve for exhaust air mode

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