Clean Air. Save Energy.

Decarbonization in foundries through heat recovery from process and hall exhaust air

22nd of August 2024

The mission of KMA Umwelttechnik: Clean Air. Save Energy.

Environmental technologies have been the center of our activities since 1973

- Family-owned **German company**
- Approx. 100 employees at HQ in Königswinter, Germany
- More than **3.000 installations in foundries**
- **Air filtration and heat recovery expert** for metal, food, plastic, textile industry and others
- Established partner for many well-known foundries **around the world**

Do you know your energy costs for heating and ventilation?

And do you know the heat energy contained in your exhaust air?

Average distribution of energy costs in a foundry

approx. 70% of energy costs
(between 56 and 81%) for:
- **melting**
- **heat treatment**
- ladle management

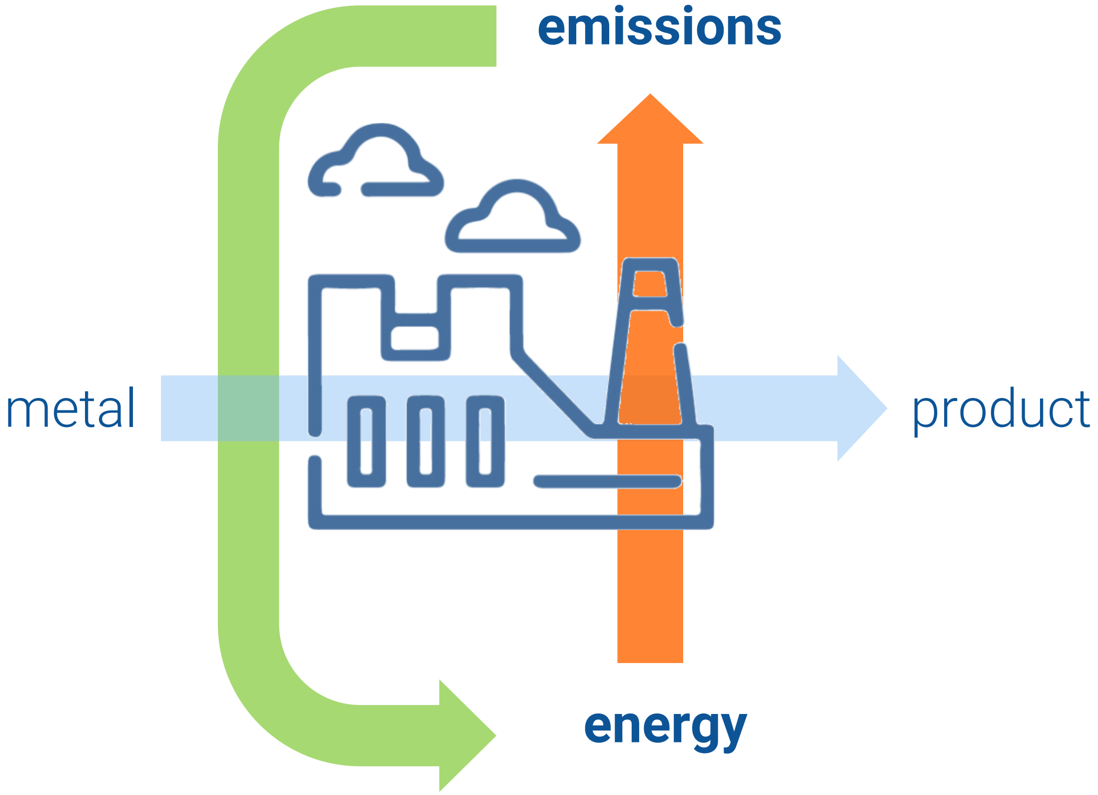
approx. 20% of energy costs
(between 15 and 24%) for:
- die management
- **ventilation and air extraction**
- other energy costs

approx. 10% of the energy costs
(between 7 and 12%) for: **heating energy**

Source: Deutsche Energie Agentur (dena, 2021) S.8:
"Systematisch Energieeffizienz steigern und CO2-Emissionen senken in der Gießerei-Industrie".

Emissions and wasted heat in the context of your foundry

Exhaust filtration and heat recovery offer valuable potential for your energy efficiency



- **Air quality** in the production halls is crucial in **competition for qualified workforce**
- Increasingly strict regulations for **industrial exhaust air and odors** (e.g. new European BREF in 2024)
- **Lowering of energy cost** is critical for **profitability**
- **Lowering of energy consumption** is relevant for European legislation
- **Mandatory CSR standards** and CO_2 reduction targets for **accreditation of supply chains**

Proven approaches for CO_2 reduction and energy cost advantadges

Approach 1: Hall ventilation with heat recovery

KMA practical example: STIHL magnesium die casting foundry

Source: STIHL (https://magnesium.stihl.de/giesserei.aspx)

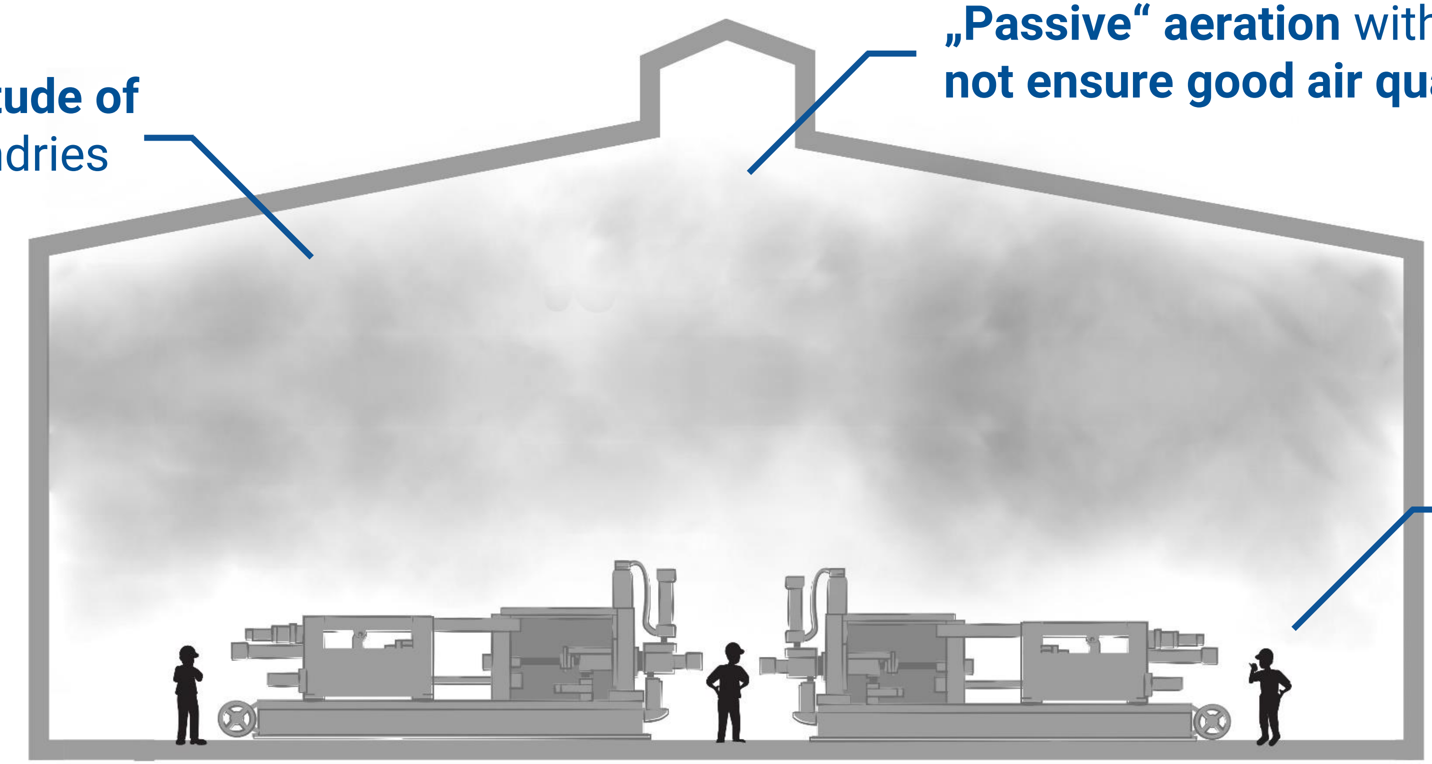
The Problem with emmissions in foundries

KMA practical example: STIHL magnesium die casting foundry

There are a **multitude of emissions** in foundries

- Release agents
- Binding agents
- Lubricants
- …

„Passive“ aeration with roof openings **does not ensure good air quality**



The emissions are **harmful to health** and **soil** the machinery and infrastructure

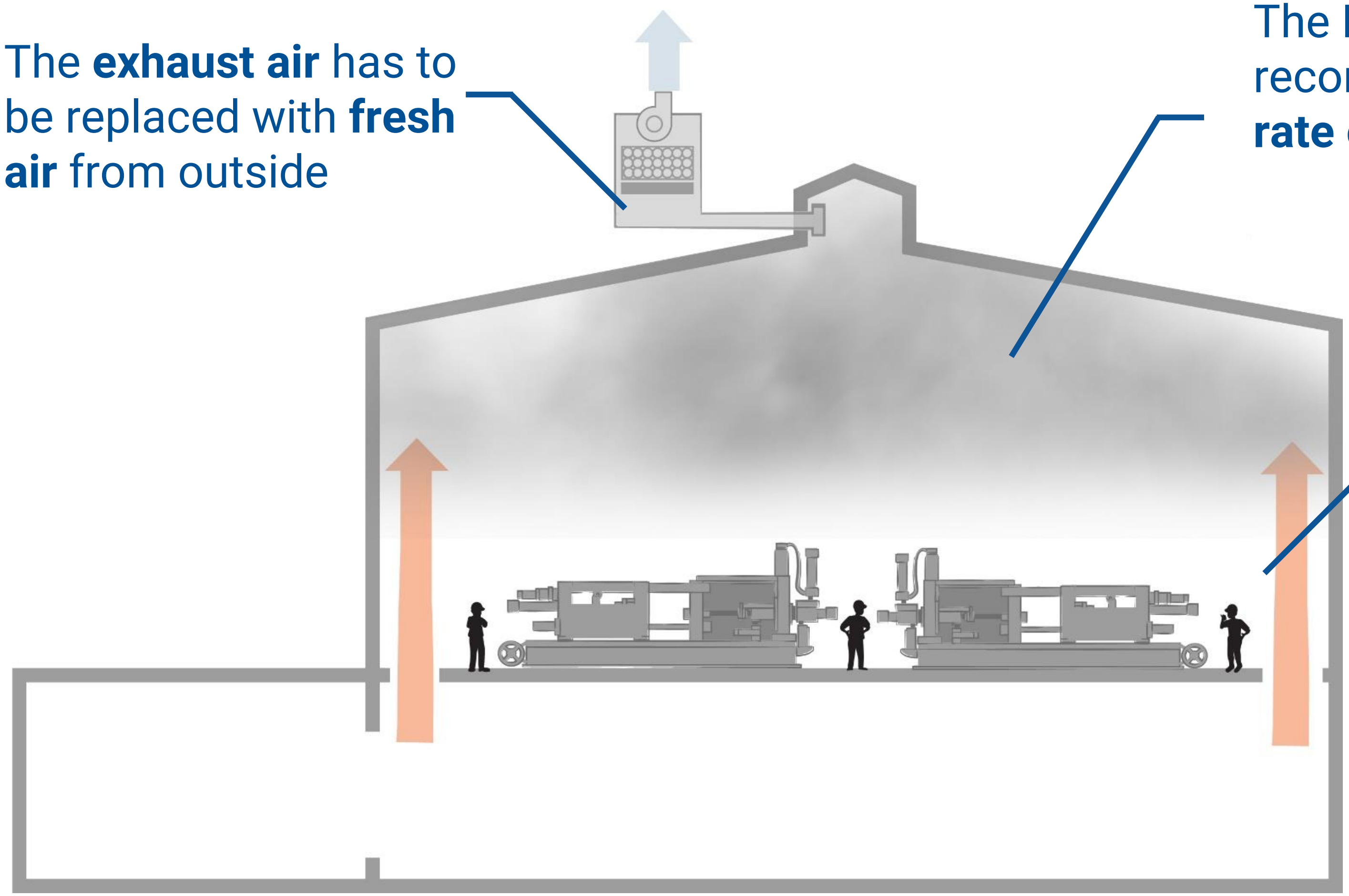
Hall ventilation with layered ventilation principle

KMA practical example: STIHL magnesium die casting foundry

The **exhaust air** has to be replaced with **fresh air** from outside

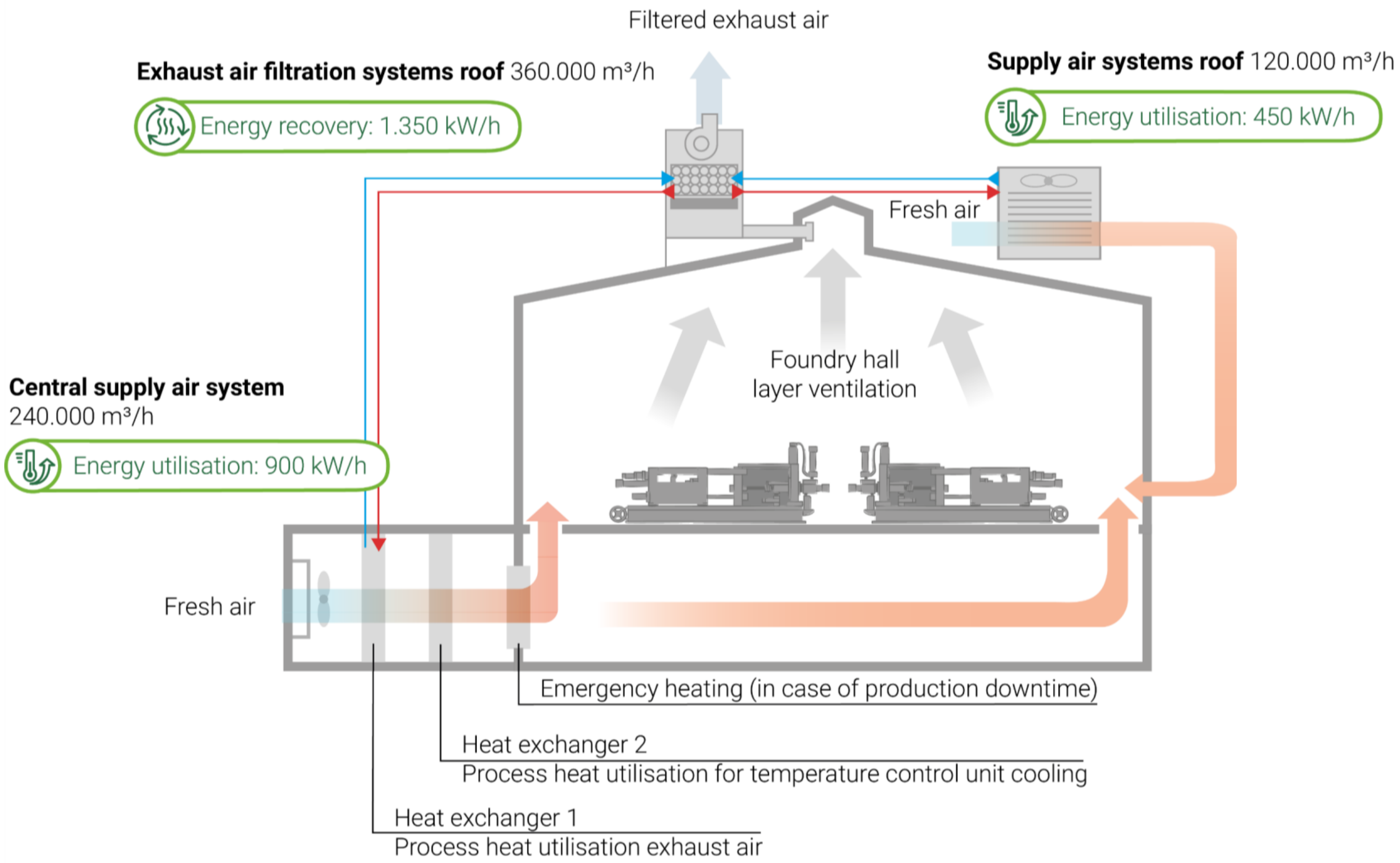
The FVLR guideline 10 (8/2014) recommends and **air exchange rate of 8-15** for foundries

The **layered ventilation principle** creates a **clean air zone** on operator level



Hall ventilation with heat recovery

KMA practical example: STIHL magnesium die casting foundry



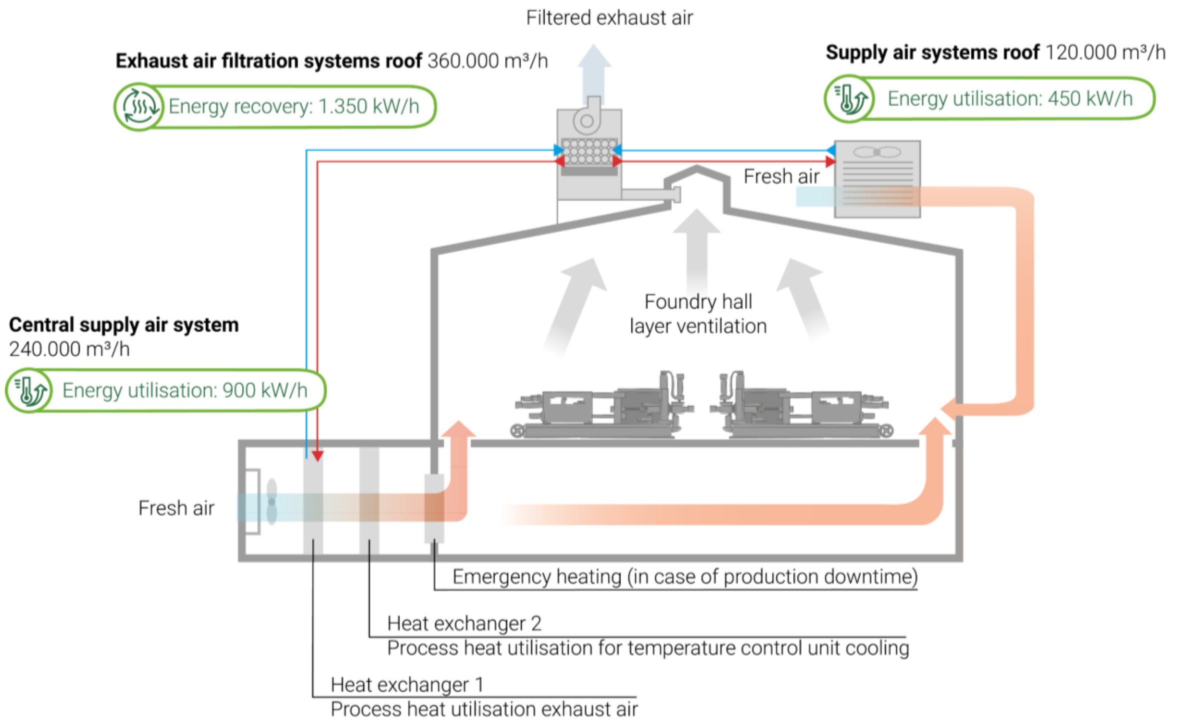
Hall ventilation with heat recovery

KMA practical example: STIHL magnesium die casting foundry

Source: STIHL (https://magnesium.stihl.de/virtuelle-werksfuehrung-stihl.aspx#r=stage-teaser)

Hall ventilation with heat recovery

KMA practical example: STIHL magnesium die casting foundry



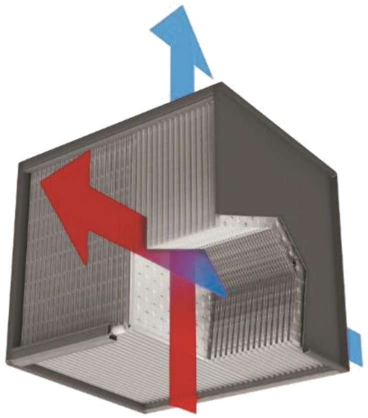
- ✓ **Air exchange rate of 13** for good air quality in the foundry
- ✓ **1.350 kW/h energy recovery** from the hall exhaust air
- ✓ **84% energy savings** compared to conventional heating
- ✓ **85% lower CO_2 emissions** (yearly savings 205t CO_2) compared to conventional heating
- ✓ Integrated **cleaning system**

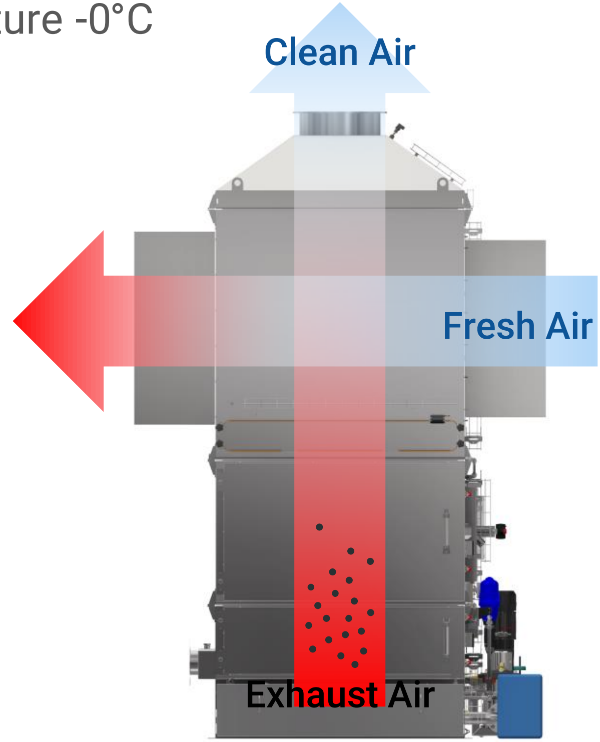
Approach 2: Hall ventilation with cross flow heat exhangers

KMA practical example: project in planning stage

Assumptions:

- 6 weeks of heating need per year
- 135h of operation per week
- COP for gas heating: 85%
- Outside temperature -0°C

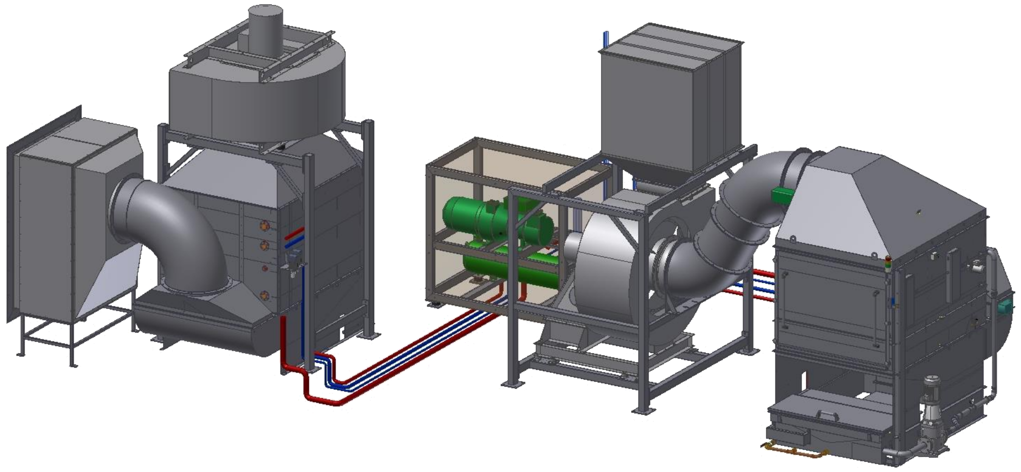


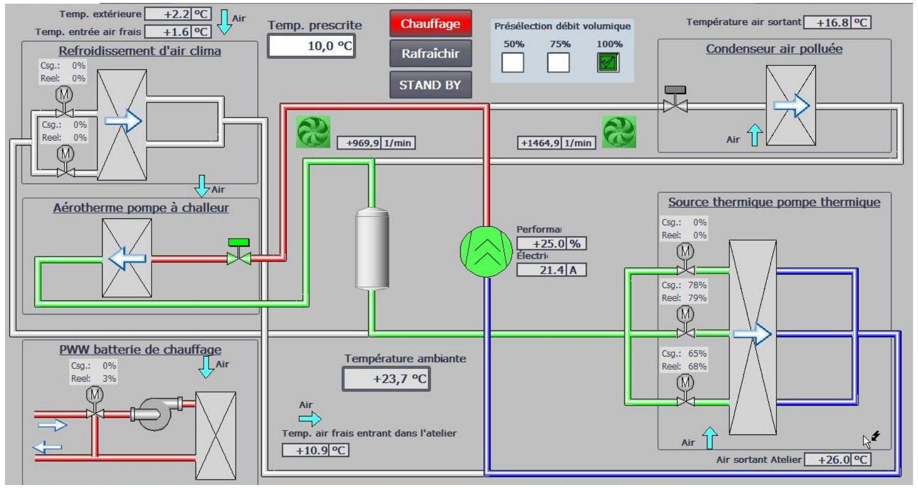


Exhaust air temperature (foundry air temperature)	**30 °C**
Exhaust air volume	270.000 m³/h
Potential for heat recovery	Approx. 1.865 kW
Energy recovery per year (with 810 operating hours)	**Approx. 1.510 MWh**
Possible **CO_2 saving** per year	370 t CO_2
Possible **CO_2 Tax savings** per year (with 40€/t in 2024)	14.800 EUR
Possible **energy cost savings** per year compared to heating with gas (with gas price of 9 Ct/kWh)	Approx. 160.000 EUR

Approach 3: Hall ventilation with heat pump

KMA practical example: foundry in Alsace, France





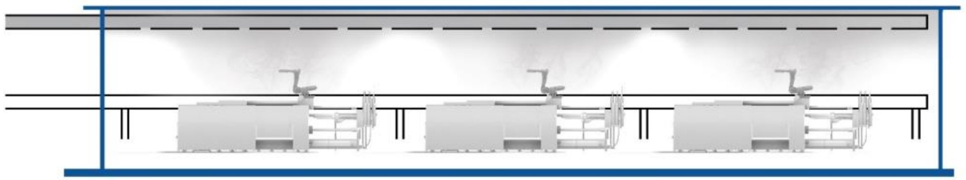
- ✓ **Heat pump** with direct heat exchanger in exhaust and supply air units
- ✓ **Heating** of the fresh air in winter and **cooling** of fresh air in summer possible
- ✓ **Very good COP of 8-10 for the heat pump** (COP = Coefficient of Performance)
- ✓ Integrated **cleaning system**

Approach 4: capture and clean emissions locally

Capturing emissions at the source and cleaning them in recirculation is especially efficient

1. No active air management

2. Hall ventilation



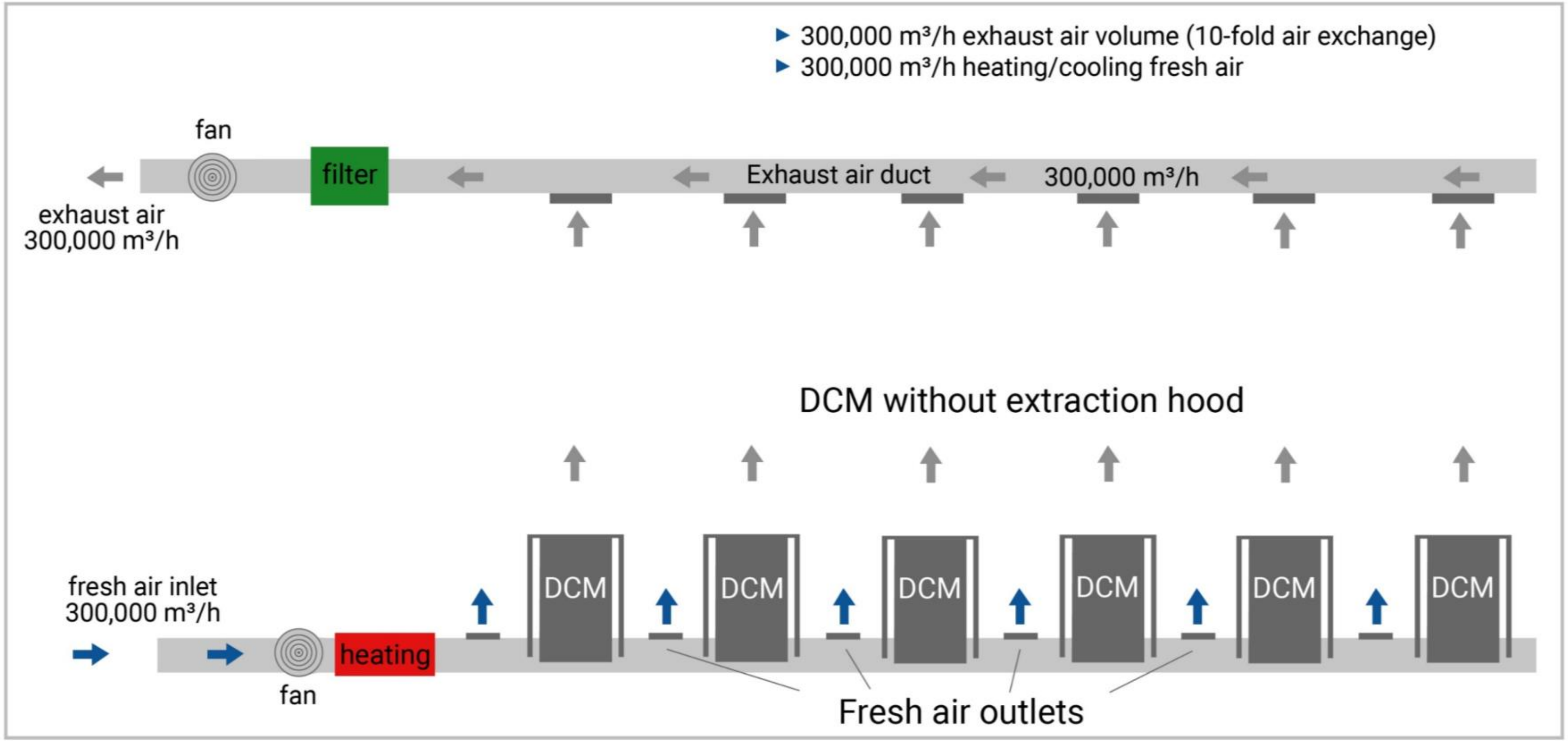
3. Local capture and cleaning of emissions

- ✓ The less contaminated air is moved the lower the **energy consumption** will be
- ✓ Air that is **cleaned and recirculated into the hall** does not have to be replaced with fresh (heated) air
- ✓ **Energy savings of >80%** possible compared to classic hall ventilation
- ✓ Combining **exhaust** operation in summer and **recirculation** in winter possible

Approach 4: capture and clean emissions locally

Exhaust air from the building must be replaced by fresh air, to be heated during cold outdoor temperatures

Central filter system without heat recovery



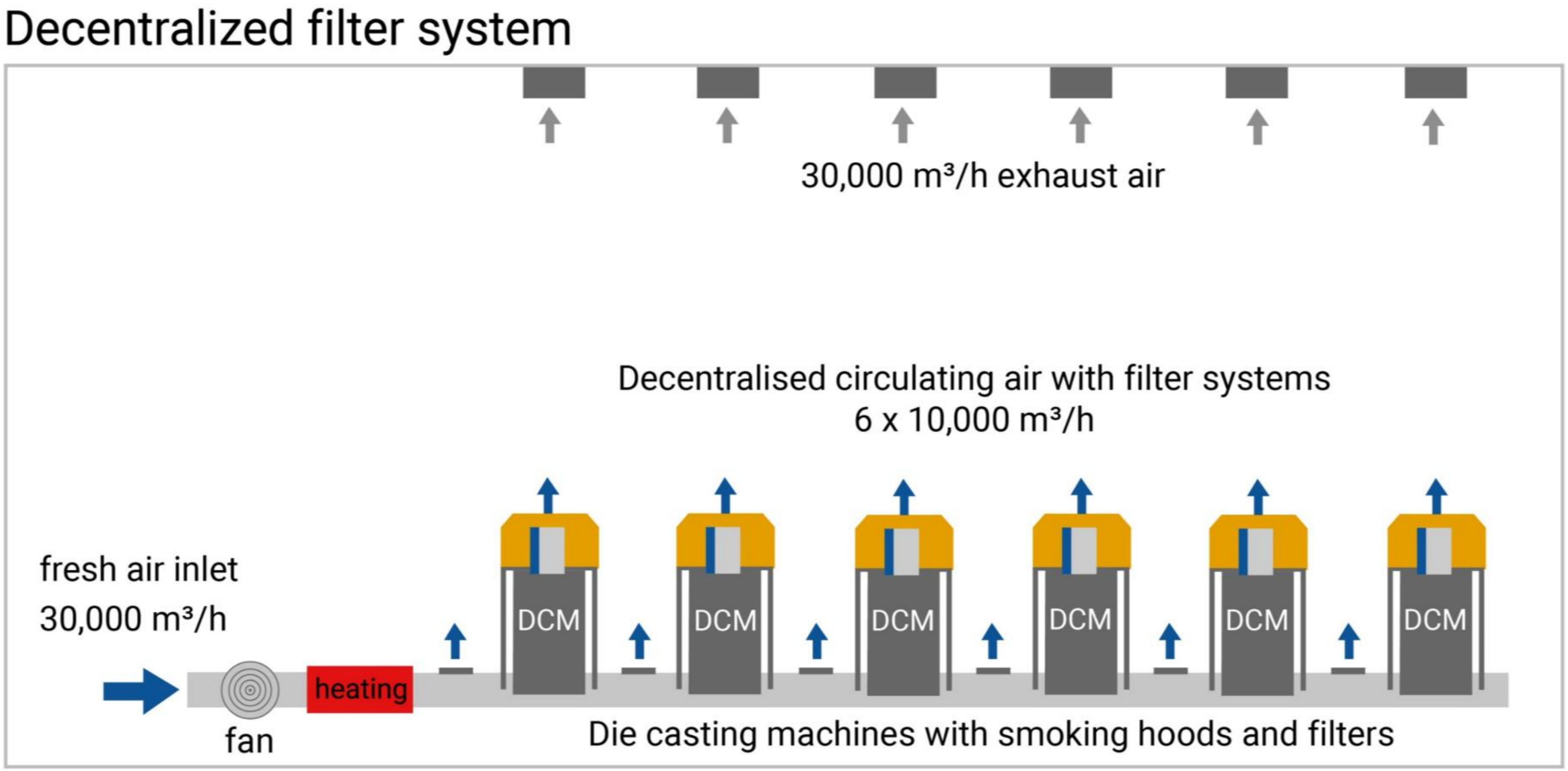
Operating costs:
254.065€ energy cost
228.214€ heating cost
= 482.279 cost per year without HR

CO_2 emissions:
464 t CO_2 by power consumption
917 t CO_2 emissions heating
= 1.382 t CO_2 emissions without HR

CO_2 tax:
2022 (30€/tons) = 41,460€
2025 (55€/tons) = 76,010€

Approach 4: capture and clean emissions locally

Local capture of emissions and air filtration in recirculation mode is the most energy efficient approach



Operating costs:
12,630€ KMA operating costs
8,333€ for ventilation
22,821€ for fresh air heating
= 43,785€ /year
CO_2 emissions:
23 t CO_2 emissions through filter system
15 t CO_2 emissions heating
91 t CO_2 emissions air exchange
= 130 t CO_2 emissions
CO_2 tax:
2022 (30€/tons) = 3,900€
2025 (55€/tons) = 7,150€

Approach 4: capture and clean emissions locally

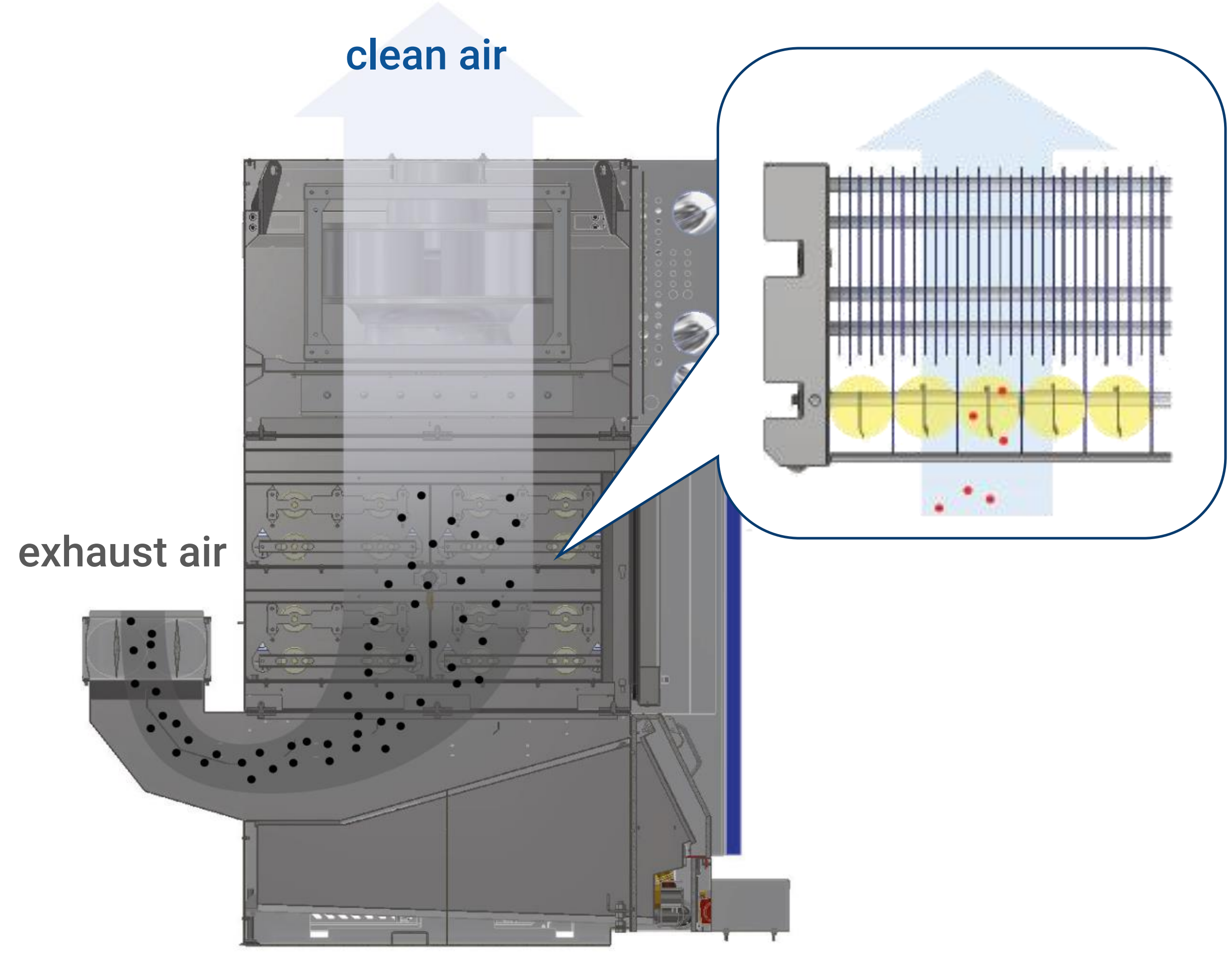
KMA practical examples: DGS, NEMAK

Source: International Aluminium Journal 12/2021

Source: International Aluminium Journal 12/2019

Approach 5: Using energy efficient filtration systems

The filtrations solutions on the market vary considerably when it comes to energy consumption



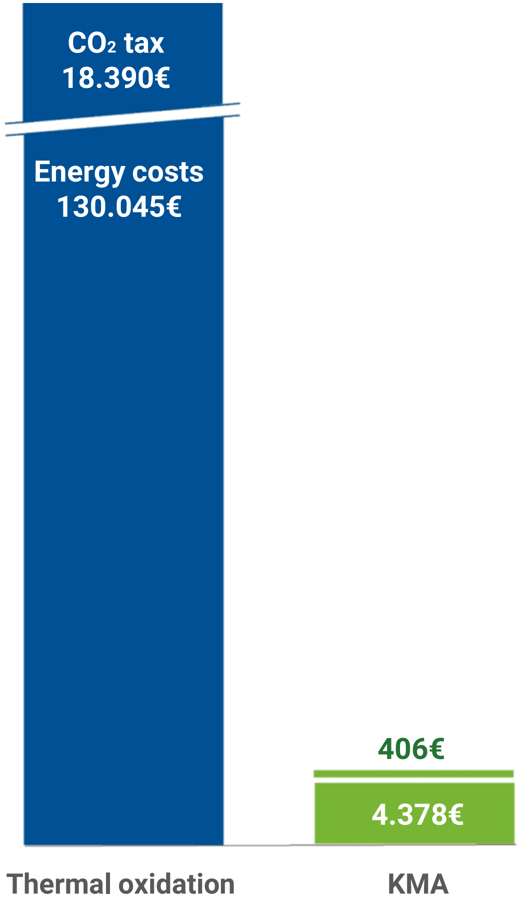
KMA ULTRAVENT® III 10000

- ✓ Electrostatic precipitators cause **marginal pressure loss and do not clog up**
- ✓ **Variable fan speed** allows for additional savings
- ✓ **Energy savings > 80%** compared to mechanical exhaust air filters
- ✓ Electrostatic precipitators **do not require exhange of the filter medium**
- ✓ Integrated **cleaning system**

Approach 5: Using energy efficient filtration systems

Massive energy savings are possible compared to thermal oxidation

Annual operating costs



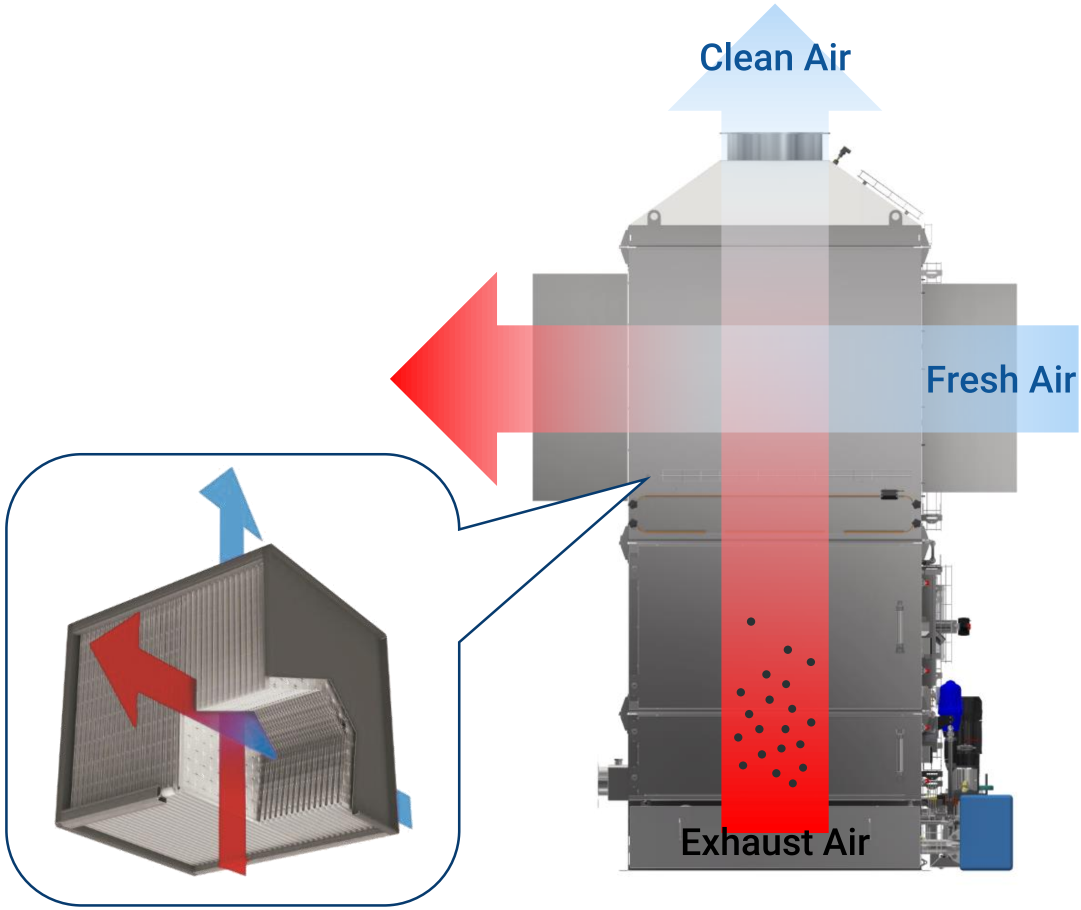
Annual CO_2 emissions

KMA practical example:

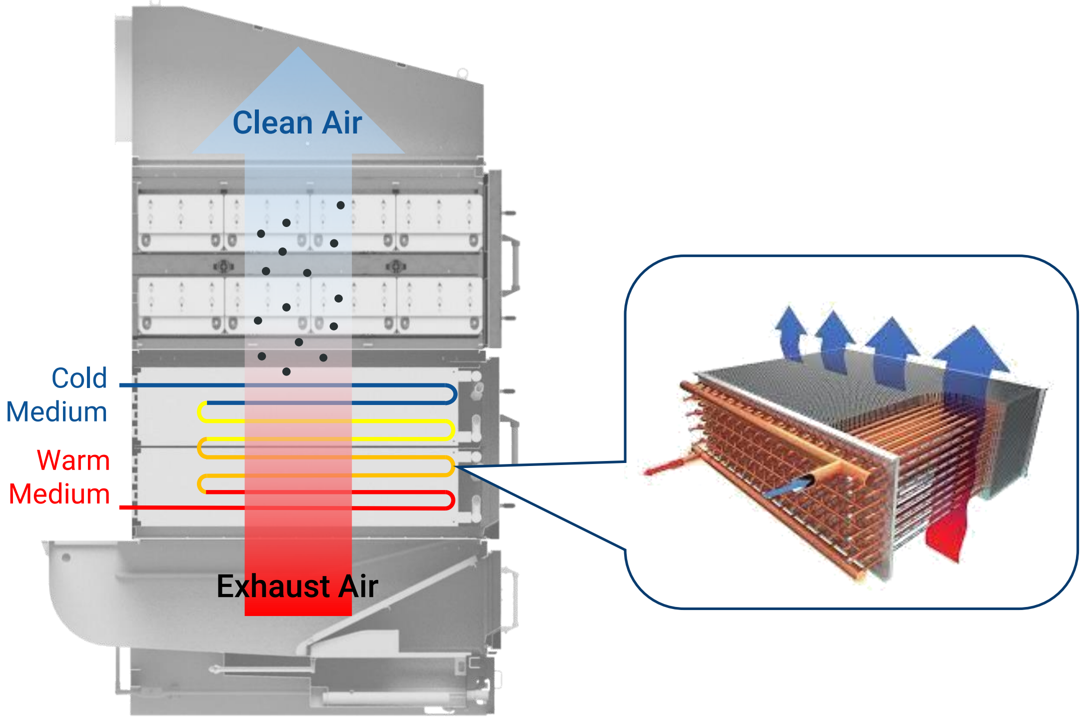
- ✓ Heat exchanger
- ✓ Electrostatic precipitator (particle separation)
- ✓ UV-Light (odor separation)
- ✓ Active carbon (VOC-separation)

Approach 5: Using energy efficient filtration systems

Exhaust air filtration and heat recovery can be combined in integrated units



KMA ULTRAVENT® M with electrostatic precipitator and cross-flow heat exchanger



KMA ULTRAVENT® M with electrostatic precipitator and fin-tube heat exchanger

Approach 6: Exploiting additional waste heat sources

Recovering energy is only half the battle – energy utilization brings challenges

energy recovery

- exhaust air volume
- temperature
- dust/soot contamination
- corrosivity

energy utilization

- heating of hall air
- Building infrastructure
- district heating
- production processes
- generating electricity (ORC)
- cooling

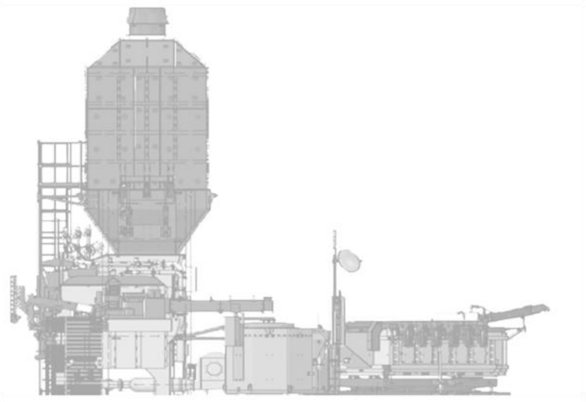
Approach 6: Exploiting additional waste heat sources

KMA practical example: ongoing design for heat recovery from aluminum melting furnaces

Application:

Shaft melting furnace in aluminum foundry for high pressure die casting

Melting capacity: 3,5t/h
Holding capacity: 8t/h
Max. 330 m³/h propane usage



Exhaust air temperature (at furnace chimney)	**590 °C**
Exhaust air volume	8.600 – 11.000 m³/h
Potential for heat recovery	Approx. 490 – 600 kW
Energy recovery per year (with 4.900 operating hours)	**Approx. 2.400 – 2.940 MWh (90°C hot water)**
Possible **CO_2 saving** per year	590 - 726 t CO_2
Possible **CO_2-Tax savings** per year (with 40€/t in 2024)	23.600 – 29.040 EUR
Possible **energy cost savings** per year when used for heating (with gas price of 9 Ct/kWh)	216.000 – 264.600 EUR

Approach 6: Exploiting additional waste heat sources

KMA practical example: ongoing design for heat recovery from aluminum melting furnaces

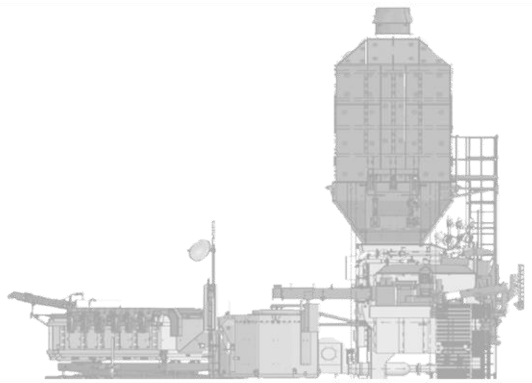
Exhaust air temperature (average)	**350°C – 500°C**
Exhaust air volume	Up to 10.000 m³/h
Potential for heat recovery	Approx. 254 kW
Energy recovery per year (with 1,000 operating hours)	**Approx. 254 MWh**
Possible **CO_2 Saving** per year	62 t CO_2
Possible **CO_2-Tax savings** per year (with 40€/t in 2024)	2.480 EUR
Possible **energy cost savings** per year when used for hall heating (with gas price of 9 Ct/kWh)	26.900 EUR

Application:

Shaft melting furnace in aluminum foundry doing sand and gravity casting

Melting capacity: 1,5t/h
Holding capacity: 4t/h
Up to 20m³/h propane usage during holding

Assumptions:
6 weeks of heating need per year



Approach 6: Exploiting additional waste heat sources

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energy utilization

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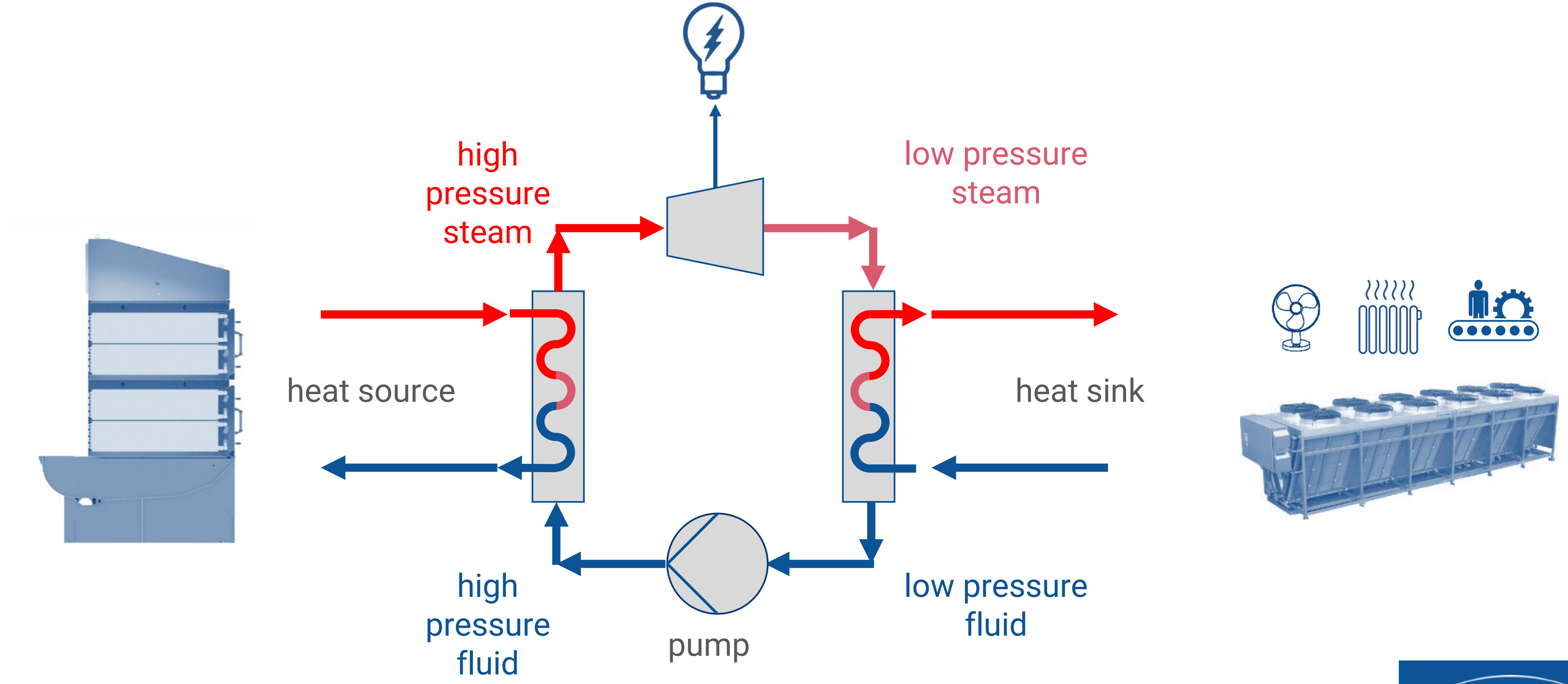
ORC systems convert part of the energy in electricity

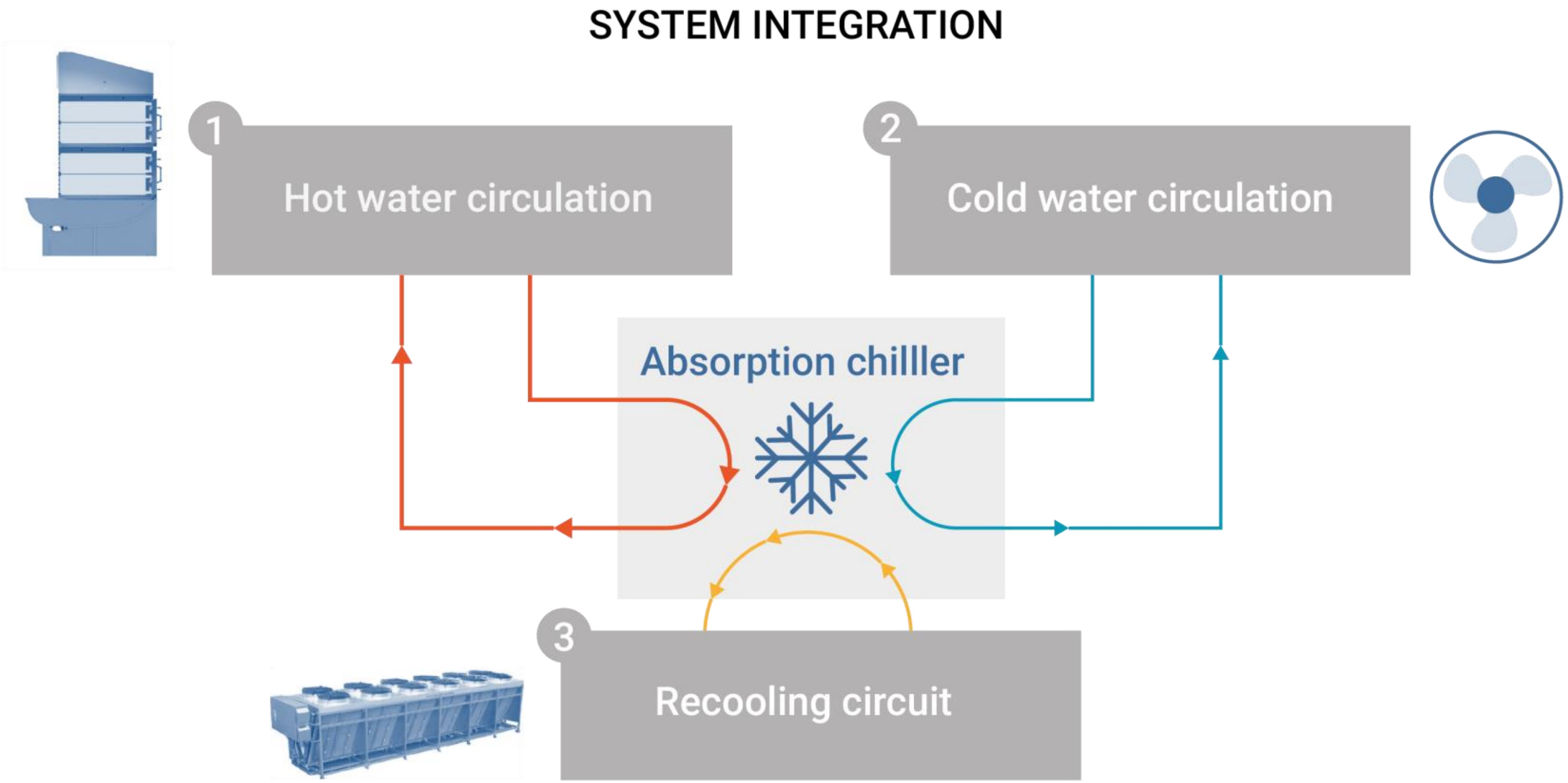
Electricity offers the most flexible usage possibilities, but the degree of efficiency is limited



Schematic representation Organic Rankene Cycle (ORC)

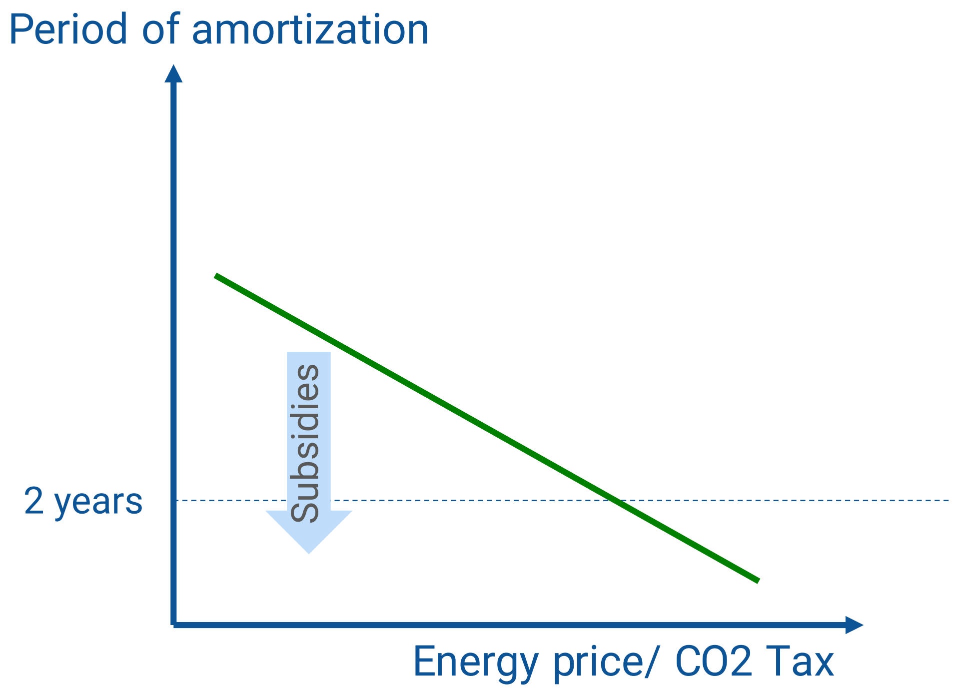
Absorption chillers use heat sources for cooling

This way, heat recovery from furnaces may be used for heating in winter and for cooling in summer



The ROI-Paradox of environmental technology

Investments in efficient environmental technology pay themselves off sooner or later!



- Consider the planned **operating lifetime,** not just the desired **amortization period**
- Anticipate increasing **energy costs** and **CO_2 taxes**
- Use **grants and subsidies**
- The earlier efficient technology and heat recovery are used, the **earlier** you can **profit from the savings**

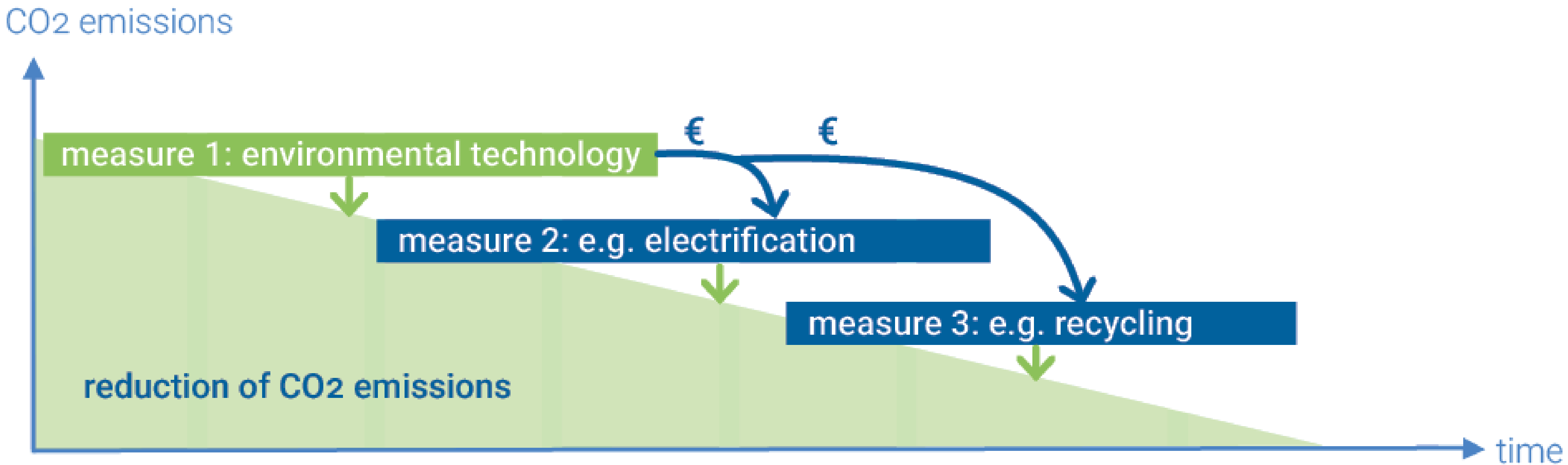
General Manager to Technical Lead:

„If we knew about it, why didn't we invest in this energy saving technology 5 years ago? We could have saved money for the last 5 years!"

Quote, KMA customer

Heat recovery should be a part in your decarbonization path

In Germany for instance overall subsidies may be levered by environmental technology investments



Let us evaluate your energy saving potential together

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