FILTER POWERING › INDUSTRY

SMART SOLUTIONS FOR SMART INDUSTRY

White Paper | 03-2026

The factory as an untapped energy resource

How to turn industrial waste heat into a competitive advantage

For decision-makers in facilities with:

boiler house | steam and condensate systems | cooling systems | compressed air | process heating

10-minute factory energy efficiency quick check

Contents

Why energy efficiency in industry is a management-level topic

The challenge: most industrial companies waste energy and water every day

Energy is no longer just an input for production. In today's economic environment, it can either be an uncontrolled cost and a source of risk, or a deliberately managed competitive advantage with a direct impact on a company's profitability (EBITDA).

In industrial operations, energy can account for **up to one third** of total production costs. At the same time, our practical experience shows that **5–15% of total energy consumption can be optimized** without changing production volumes. For a medium-sized factory, this often represents **hundreds of thousands of euros** in additional value per year that would otherwise be lost.

5-15%
of energy costs can typically be optimized

At a global level, heat energy is one of the most critical aspects of energy use. Heat accounts for approximately 50% of global final energy consumption, significantly more than electricity (~20%) or transport (~30%). At the same time, heat production and use are responsible for over 40% of global energy-related CO_2 emissions. This makes the decarbonization of heat, particularly in industry, one of the biggest challenges in achieving climate targets, but also one of the largest untapped opportunities.*

~50%
of global final energy consumption is heat

Over 40%
of energy-related CO_2 emissions are linked to heat

~50%
of total heat energy is consumed by industry

This is why industry is one of the key sectors where energy and climate challenges will either be solved — or remain unresolved.

The International Energy Agency (IEA) has repeatedly emphasized that energy efficiency is the "first fuel" of global decarbonization and one of the most powerful levers available to industrial companies to reduce emissions and improve economic performance.**

Most factories do not waste energy intentionally. They simply do not manage energy as a complete and continuously optimized system.

Waste heat recovery, condensate return to the boiler house, cooling optimization, and boiler efficiency are often treated as separate topics. In reality, they are all part of one integrated system.

This White Paper explains how to view the factory as a complete energy system and how to turn industrial waste heat from a cost into business value.

---

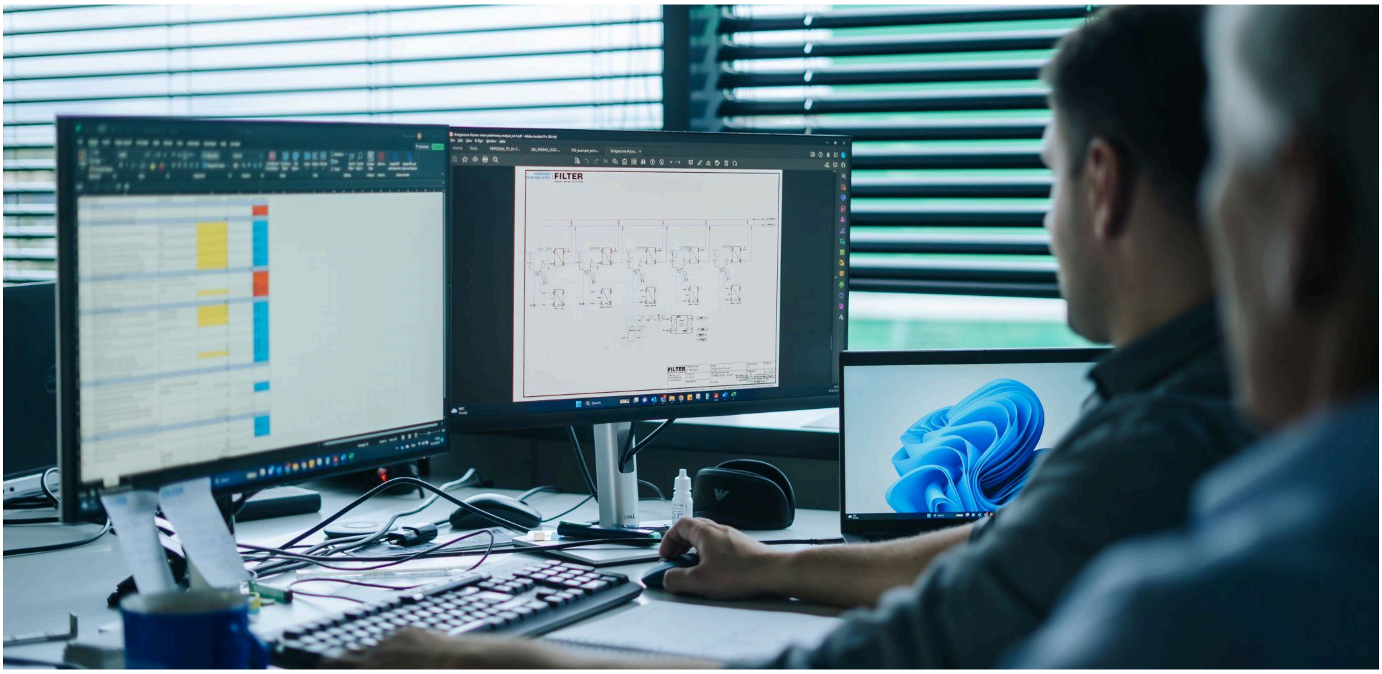
* Source: World Economic Forum, 2023 We need to rethink the way we heat ourselves. Here's why

** Source: IEA, 2022 Energy Efficiency

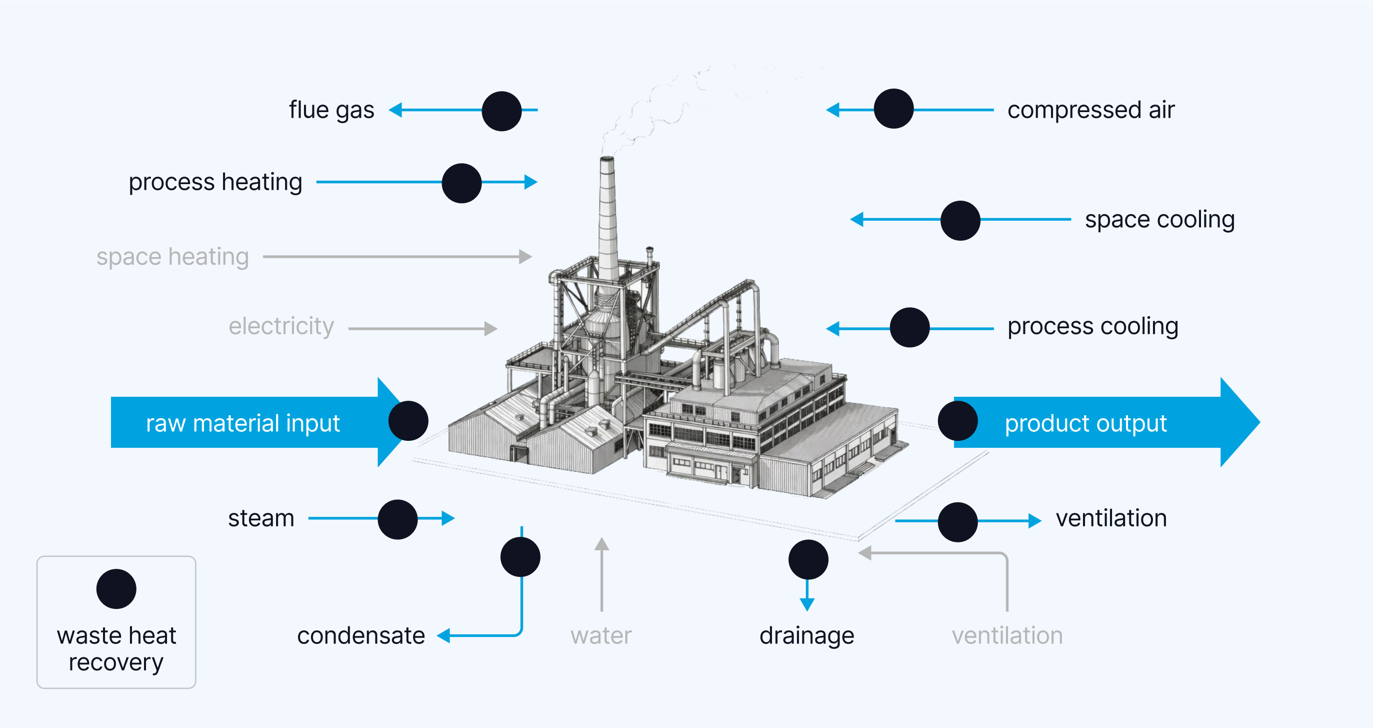
Where do hidden costs and losses occur?

In every industrial facility, waste heat is generated and hidden costs occur.
The most common sources include:

- flue gases from the boiler house
- steam systems (steam leaks, faulty steam traps)
- incomplete condensate return and contamination
- cooling systems
- air compressors
- ventilation systems
- uninsulated valves, steam traps, pipes and fittings
- missing or insufficient data



When this energy is released into the environment without recovery, it represents a direct financial loss. Energy efficiency is not the performance of a single piece of equipment, but the result of how the entire energy system operates. By mapping processes as a whole, it's almost always possible to identify where previously lost waste heat can be recovered and turned into value.



The factory as an integrated energy system. When approaching a factory as an integrated energy system, the first step is to map all energy inputs and outputs, as well as the temperature, flow rate, and end-use of each energy stream. Only then is it possible to determine which areas require investment and which can be improved through better operational control.

Examples:

- A flue gas temperature of **200–250 °C at the stack** indicates that a significant amount of useful heat is being lost with the exhaust gases. This loss can be reduced using an **economiser**.
- Process cooling that removes heat from production but does not reuse it within the system results in double cost: first to generate the heat, and then to remove it.
- Hot water discharged to drainage without heat recovery represents a direct and avoidable loss.

What are value-creating solutions?

1. Immediate savings

In many audits and site visits, we identify simple improvements — often referred to as “low-hanging fruit” — that require minimal investment but deliver significant value.

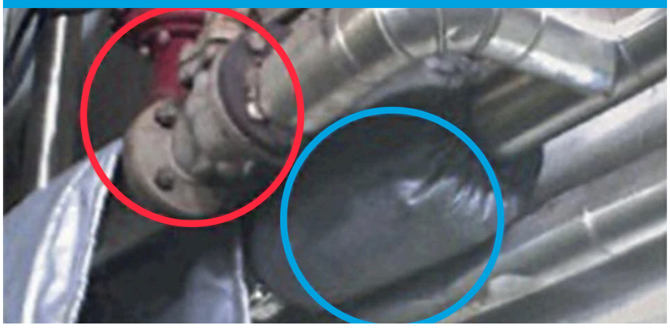
- **Repair or replacement of faulty steam traps provides immediate energy savings and eliminates safety risks.**
  In addition to fast payback, this is also a safety-critical issue. Faulty steam traps can cause water hammer in pipelines, while leaks pose burn risks to personnel and may create slippery surfaces.

  > **Typical payback: from 2 months**

- **Thermal insulation can reduce heat losses by up to 90%.**
  All surfaces above **40 °C** should be insulated, including boiler surfaces, steam and condensate piping, and valves.

  > **Typical payback: ~1 year**

Normal camera



Thermal camera

For example, at a process temperature of **160 °C**, the heat loss from a single uninsulated DN100 control valve is approximately **1,199 W**. In continuous operation, this can result in up to **10.5 MWh of energy loss per year per valve**. Assuming a heat energy cost of **45 €/MWh**, this corresponds to approximately **€470 of hidden energy cost** per valve per year. If a factory has, for example, **100 similar valves**, the total cost can reach approximately **€47,000 per year**.

** Assumptions: air velocity 2 m/s, ambient temperature 25 °C, emissivity 0.95, operating hours 8,760 h/year. Calculation based on a flanged globe valve.*

- **Heat exchangers are another typical low-investment solution.** They allow existing heat to be transferred from one stream to another, for example for preheating processes within the factory.

According to Spirax Sarco, the typical payback period for a **flash steam heat exchanger (EVC)** is around **one year or less**, depending on operating conditions and energy costs.

- These systems are typically installed on condensate tank vent lines or boiler feedwater tank vent lines.

Typical payback: ~1 year

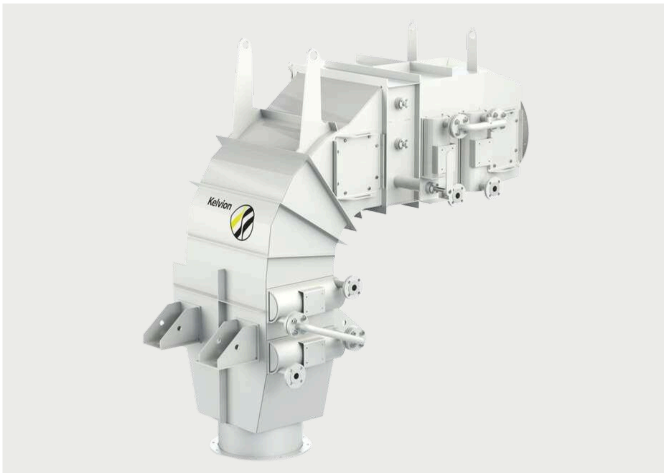
2. Boiler house efficiency and flue gas heat recovery

A flue gas economiser should be a standard component of any properly designed boiler house.

Economisers enable:

- 4–10% reduction in fuel consumption
- improved boiler efficiency
- reduced CO_2 emissions

Typical payback: 1–2 years



3. Integration of cooling and waste heat

In industrial processes, cooling is often applied to streams with temperatures in the range of 30–60 °C. This temperature level is typically too low for direct reuse in production.

Industrial heat pumps make it possible to upgrade this low-grade waste heat to temperatures of up to **180 °C**, enabling its reuse for:

- preheating of process water
- space heating
- process support
- steam generation

This represents the next level of energy efficiency: upgrading low-grade energy into valuable heat.

Oilon industrial heatpumps

4. Energy generation from waste heat and by-products

In certain cases, it is possible to generate energy from waste heat or process by-products using advanced technologies such as **absorption chillers, Organic Rankine Cycle (ORC) systems, microturbines, combined heat and power (CHP) systems.** These solutions improve energy security and reduce dependence on volatile energy markets. Since every industrial facility is different, the optimal solution must always be selected based on the specific process conditions and energy flows.

5 MW combined heat and power (CHP) plant with biogas upgrading at a wastewater treatment facility

FILTER designed and constructed a **5 MW combined heat and power (CHP) plant** at the Paljassaare wastewater treatment facility, enabling the efficient utilization of locally generated biogas.

- The solution produces up to **2.1 MW of electricity** and **2.2 MW of heat**, and consists of two INNIO Jenbacher gas engines, a biogas upgrading system, and heat exchangers.

JENBACHER INNIO
Distributor New Units & Services

- A new biogas infrastructure, including metering, drying, compression, and purification systems, ensures a stable and high-quality fuel supply.
- The upgraded biogas can also be directed to existing boilers, increasing system flexibility and reducing dependence on external energy sources.

ROI example: energy efficiency solution for a medium-sized manufacturing facility

An energy efficiency solution was implemented in a continuously operating food industry plant. Production volumes were not changed; instead, the existing system was optimized.

- 8 t/h natural gas-fired steam boiler
- Process cooling load of approximately 0.5 MW
- Annual operating time of ~8,000 hours

Identified potential

Recovered waste heat from flue gas: **0.2 MW → ~1,400 MWh/year**	Avoided electricity consumption for cooling: **~300 MWh/year**
Recovered waste heat from production processes: **0.5 MW → ~3,500 MWh/year**	Total energy impact: **~5,200 MWh/year**

By integrating a heat pump and additional heat exchangers into the system, it is possible to further upgrade and utilize higher-temperature heat to support production processes.

Project payback:
~3.6 years

Additional potential with a heat pump, upgraded heat recovery:
0.15 MW → ~1,050 MWh/year

Energy efficiency solutions can be implemented step by step, starting with simpler measures. In this example, three main stages can be identified.

The diagram below illustrates how energy flows can be connected and optimized across the factory.

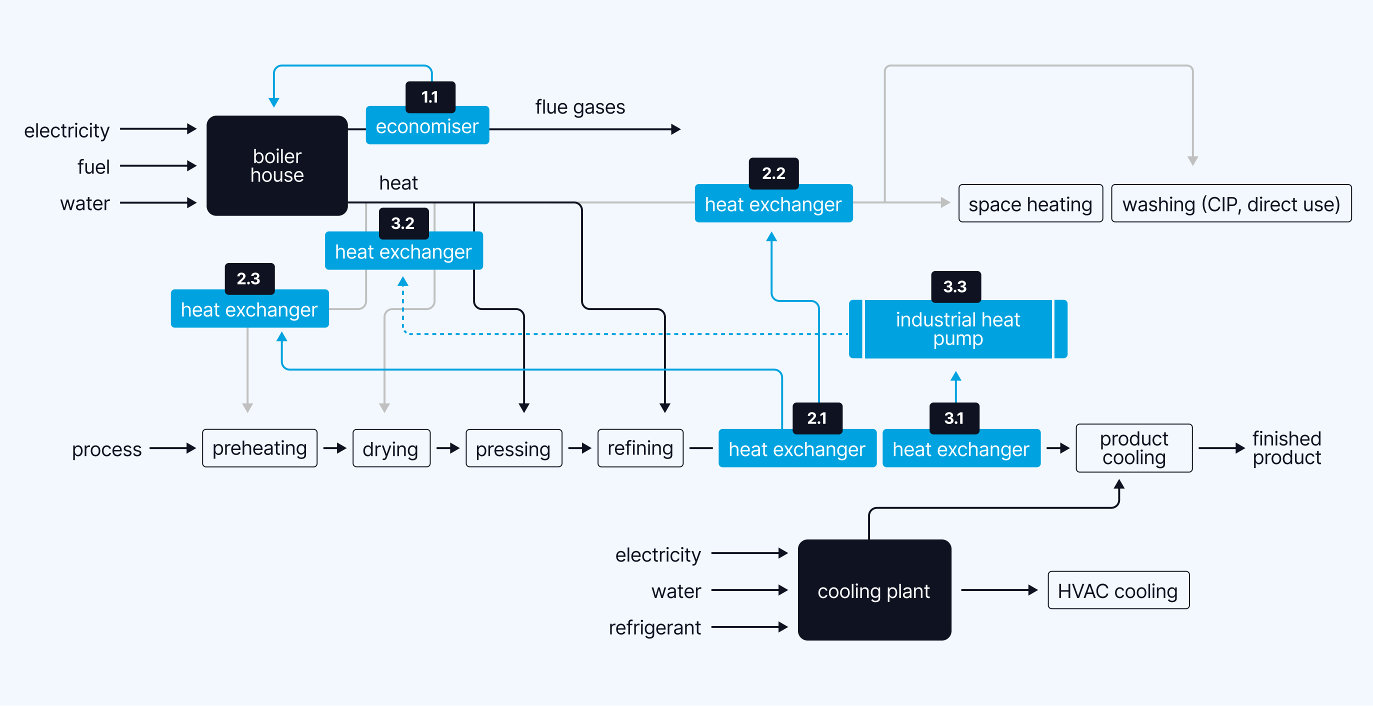


Figure: Example of an energy efficiency solution for a medium-sized food industry facility.

Stage 1	Installation of an economiser (1.1).
Stage 2	Installation of heat exchangers to recover waste heat from production processes (2.1–2.3)
Stage 3	Integration of additional heat exchangers and a heat pump (3.1–3.3)

ROI breakdown by solution

Solution	Recovered energy (MWh/year)	Annual financial impact (€)	Estimated investment (€)	Payback period (years)
Waste heat recovery from flue gas	1400	63 000 €	250 000 €	~4,0
Waste heat recovery from production processes	3500	157 500 €	600 000 €	~3,8
Avoided electricity consumption for cooling	300	24 000 €	80 000 €	~3,3
Total	**5200**	**244 500 €**	**874 000 €**	**~3,6**
Heat recovery with heat pump	1050	54 000 €	300 000 €	~5,5

› This illustrates that a step-by-step approach allows companies to prioritize quick wins first and implement more capital-intensive solutions in later stages.

** The calculations are based on a gas price of €45/MWh and an electricity price of €80/MWh.*

Where to start?

Efficient energy use does not begin with technology.
It begins with the right mindset and the right questions.

1. Start with a 10-minute factory energy efficiency assessment

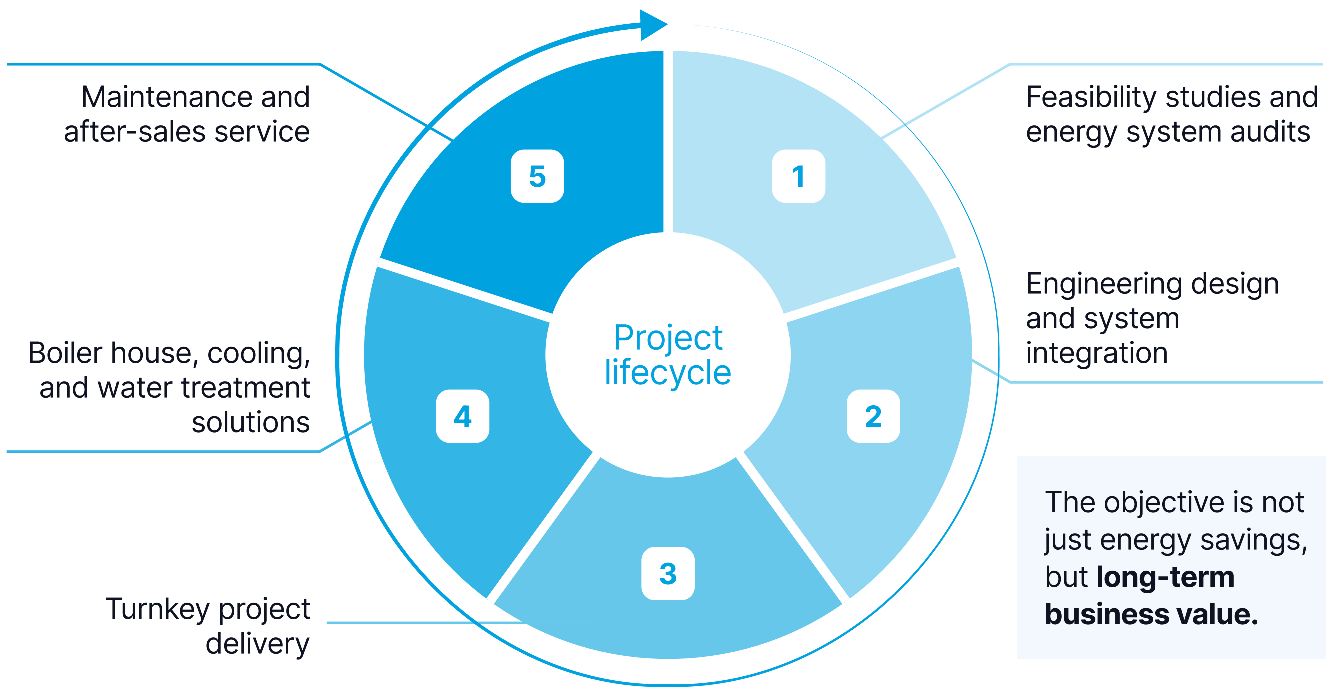
Ask your technical team, is the steam and condensate system regularly inspected for leaks, is condensate temperature measured and monitored, is heat from process cooling being recovered and reused? Etc.

If you receive more than five “No” or “Don’t know” responses, there is clear untapped potential in your factory.

2. Validate with a process energy audit

Without data and a proper audit, decisions are often based on assumptions. An energy audit helps to collect reliable data, perform measurements, identify heat inputs and outputs, and build a clear cost-benefit analysis. This creates a solid basis for informed decision-making.

FILTER acts as an engineering partner throughout the entire project lifecycle:



The objective is not just energy savings, but **long-term business value.**

PROCESS ENERGY EFFICIENCY AUDIT

An audit is essential for making informed decisions. An experienced FILTER process engineer analyses the complexity of your processes and energy use, identifies untapped energy potential in your facility, and develops recommendations to improve energy efficiency, including a financial feasibility assessment based on actual operating data.

The audit covers:

- energy and resource efficiency (identification of energy inputs and outputs)
- heating and cooling systems
- water and wastewater systems
- steam and condensate systems
- flue gas systems
- control equipment
- valves and fittings

A typical factory audit consists of the following steps:

Data collection

Comprehensive information is gathered about the facility, including its design, operation, maintenance practices, fuel types, water quality, energy consumption, emissions, and related costs.

On-site inspection

The facility is visited to physically inspect equipment, installations, systems, and processes.

Measurements

Energy flows and losses are actively monitored and measured. This includes evaluating parameters such as fuel consumption, heat production, flue gas temperatures, heat losses through radiation, and heat recovery potential.

Improvement opportunities

Potential improvements include equipment upgrades or replacements, process optimization, maintenance improvements, and energy management measures.

Cost-benefit analysis and audit report

A detailed report is prepared, summarizing the current situation, key findings, and recommended improvements, including a financial evaluation of proposed measures.

Learn more or request an audit: **filter@filter.eu**

10-minute factory energy efficiency assessment

This quick assessment helps you evaluate, in just 10 minutes, whether there is untapped energy potential in your factory. Mark your answers. If you respond “No” or “Don’t know” to more than five questions, there is likely untapped potential.

1. STEAM AND CONDENSATE

- Do you know what percentage of condensate is returned to the boiler house?
- Is condensate temperature measured?
- Have steam leaks been systematically identified within the last 12 months?
- Is the operating pressure of the steam system aligned with actual demand?
- Are steam traps tested regularly?

If you answered **“No”** to several questions, there is likely potential in steam leaks, low condensate return rates, or a poorly designed or maintained steam and condensate system.

> In such cases, the factory often pays for the same heat twice — first to generate it, and then again through additional water and energy consumption in the boiler house.

2. WASTE HEAT

- Is the boiler flue gas temperature known?
- Do you know the overall efficiency of your boiler house?
- Is an economiser installed on the boiler? If yes, is the economiser operating at full capacity?
- Is waste heat from compressors or processes being utilized?
- Is space heating partially covered by waste heat from production processes?

If you answered **“No”** to several questions, part of the energy is likely leaving the system through flue gases, compressors, or process cooling.

These streams often contain the largest untapped energy potential, which can be recovered and reused in production processes or for space heating.

3. PROCESS COOLING AND VENTILATION

- Is heat from process cooling simply discharged?
- Is cooling controlled based on actual demand?
- Does the ventilation system operate independently of production (e.g. continuously)?

If you answered **“No”** to several questions, energy is likely being removed from processes through cooling or ventilation without being recovered.

In such cases, it is often possible to reduce both cooling electricity consumption and heating demand by integrating these systems.

4. WATER AND DRAINAGE

- Do you know where process water goes after use?
- Is hot water discharged to the sewer without heat recovery?
- Is technical water quality continuously monitored?
- Is chemical dosing based on actual measured demand?

If you answered **“No”** to several questions, energy may be leaving the system together with hot water or wastewater.

These streams often provide opportunities to recover heat, reduce water consumption, and optimize chemical usage.

Learn more or request an audit: **filter@filter.eu**

FILTER is an international engineering company with over 30 years of experience in industrial energy, steam, and water solutions.

We design, build, and maintain integrated solutions that improve energy efficiency, reliability, and process performance.

We are a long-term partner to companies operating in sectors critical to society, from drinking water and food production to pharmaceuticals and district heating.

Our mission

Our mission is to build a smarter future where industries do not waste energy or water, and where systems operate reliably and sustainably, ensuring peace of mind for all.

Technical consultation:

Estonia

Oskar Imre Saik, MSc
Thermal Energy Engineer, Level 7
Process Sales Engineer, FILTER Solutions OÜ
oskar-imre.saik@filter.eu

Lithuania

Simas Dailidonis
Sales Manager, FILTER UAB
simas.dailidonis@filter.eu

Latvia

Mārcis Balodis
Sales Engineer, FILTER SIA
marcis.balodis@filter.lv

Nauris Maskalāns
Sales Engineer, FILTER SIA
nauris.maskalans@filter.lv

FILTER
Powering Industry

A smarter future.
Greater peace of mind.

filter@filter.eu ↗ filter.eu ↗