Energy Solutions

Food & Beverage industry

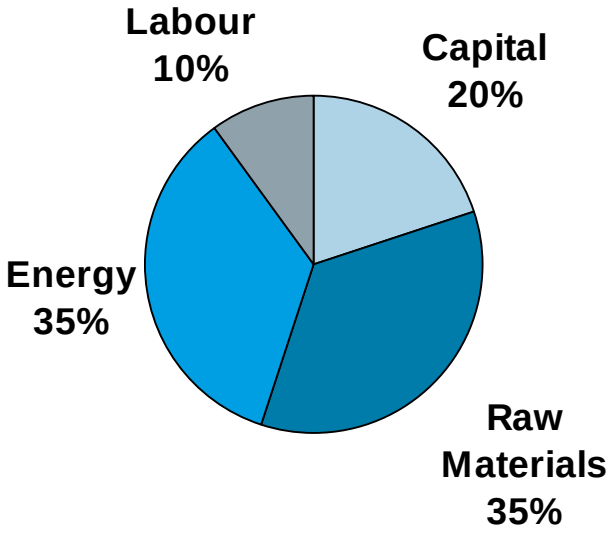
Why is energy management an important topic?

- **Energy prices influence production costs,**
- End-consumer looks for sustainable products, companies' green image and sustainable behavior,
- **Regulations require energy efficient production processes,**
- **Tax incentives are placed for certification according DIN EN ISO 50001 in some countries**,
- Reduction of emissions of greenhouse gases (GHG) is important.
- **Energy is a driver for industrial competitiveness,**

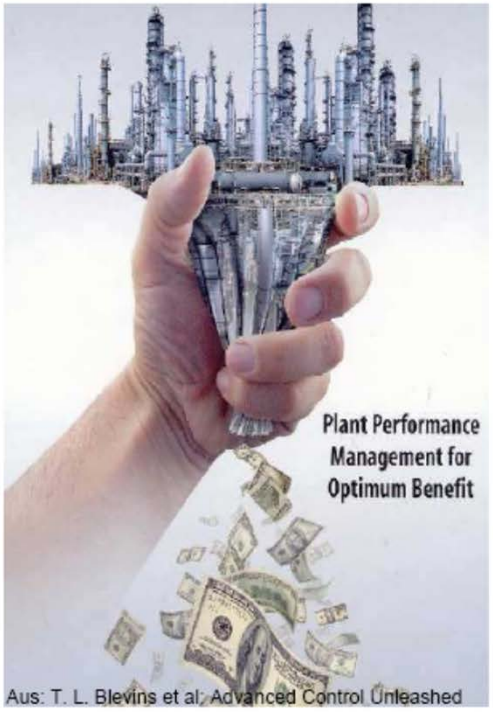
....why that?

Source: http://www.fooddrinkeurope.eu/documents/brochures/brochure_CIAA_envi.pdf and http://sustainability.fooddrinkeurope.eu/uploads/section-images/USE_SustainabilityReport_LDFINAL_11.6.2012.pdf

Focus on Energy Usage



Cost Drivers in the Chemical Industry
(Source: Bayer Industry Services)



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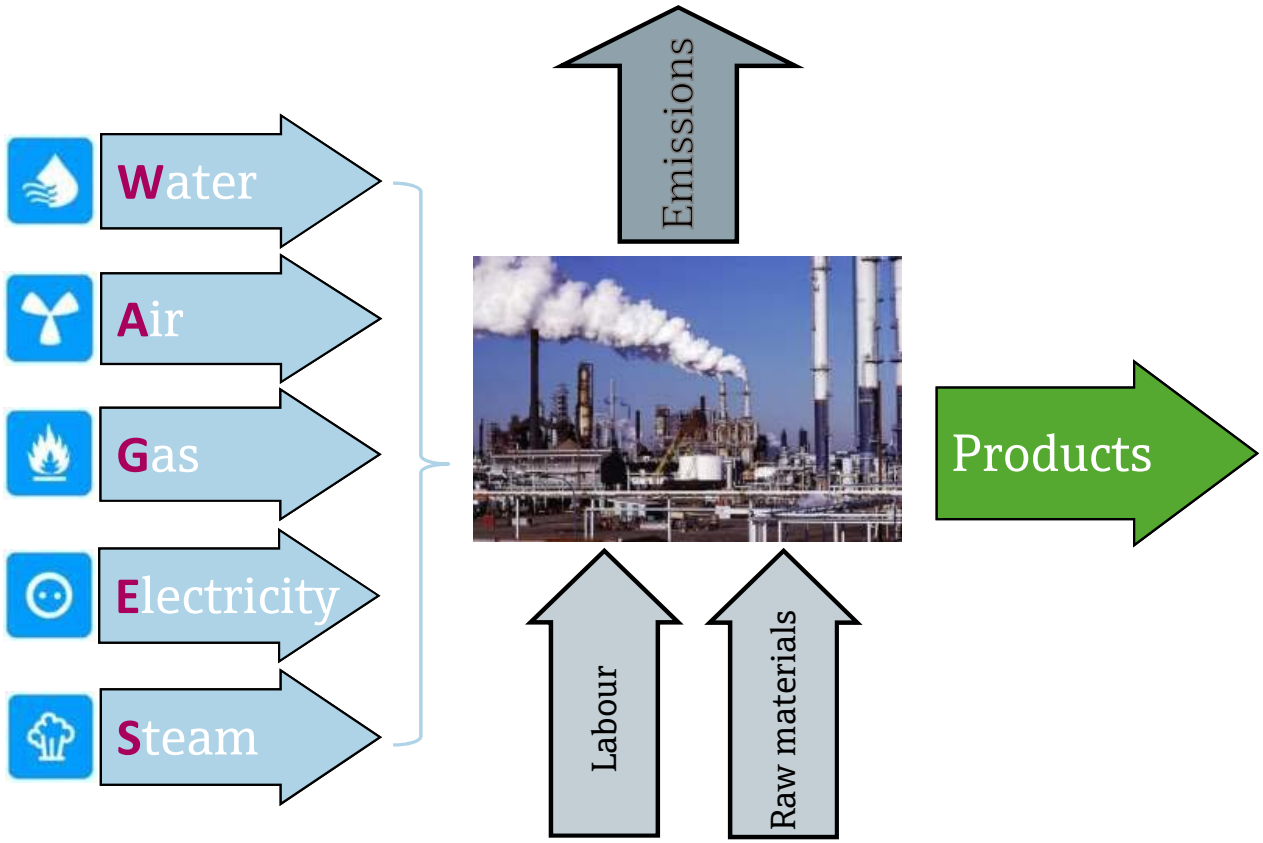
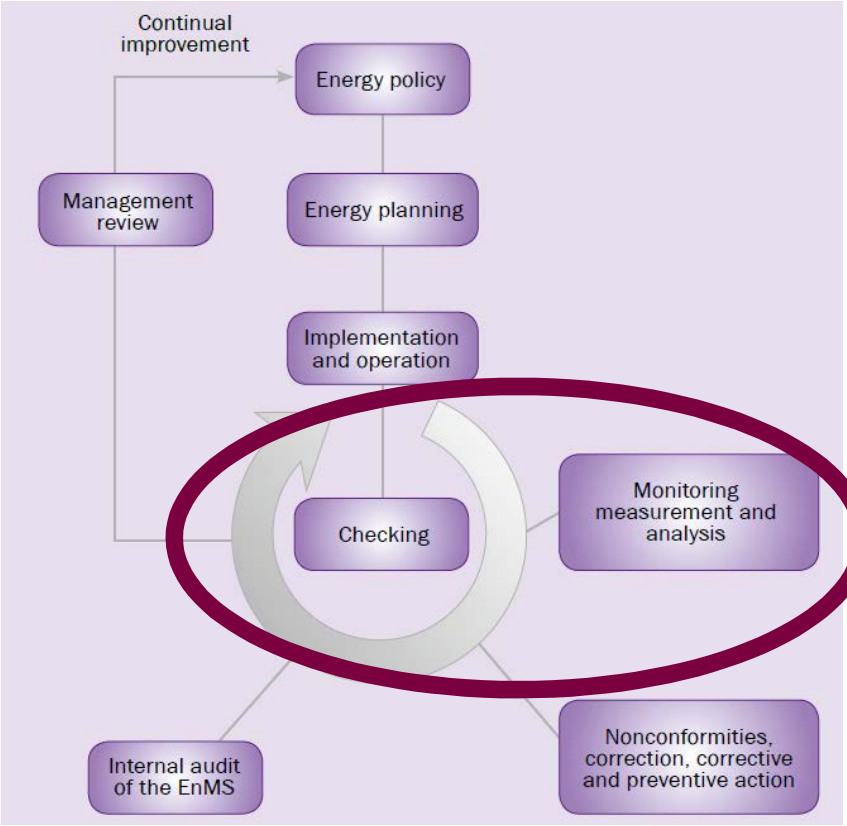
Application areas



International Energy Management Standards e.g. EN16001/ISO50001 – Plan Do Check Act Circle



Environmental Management According EMAS+ISO 14001

A.5. Checking

A.5.1. Monitoring and measurement

The organisation shall establish, implement and maintain a procedure(s) to monitor and measure, on a regular basis**, the key characteristics of its operations that can have a significant environmental impact.** The procedure(s) shall include the documenting of information to monitor performance, applicable operational controls and conformity with the organisation's environmental objectives and targets.

The organisation shall ensure that calibrated or verified monitoring and measurement equipment is used and maintained and shall retain associated records.

Energy Savings Process

Controlling of Energy Data

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Data Collection

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Energy Analyses

Energy Reporting

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Customer

Optimize

Transparency of Consumption

Energy Monitoring, Analysis and Reporting

Utilities

Steam
Air
Electricity
Gas
Oil
Water
Heating
Cooling

Process Fluids

Analysis and Reporting

Visualization and Recording

Calculation and Transmission

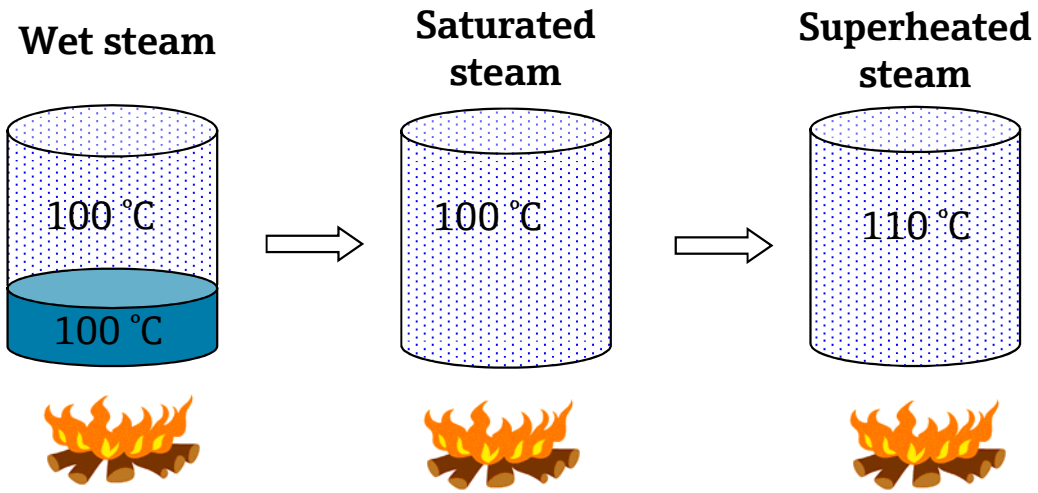
Energy Measurement

Energy Monitoring Software (EMS)

Steam Applications

Definition of steam

State of aggregation and types of steam



Temperature and pressure of wet steam and saturated steam is equal!
Boiling temperature = Saturated steam temperature

Visible steam quality discharging to ambient

- Good steam quality: invisible

- Poor steam quality: liquid droplets visible

Prowirl 200 optimized for steam applications!

Wet steam measurement

- Worldwide unique
- Detection of “wet steam”

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Prowirl 200 optimized for steam applications!

Increased safety and efficiency for plant operation!

- **To avoid water/steam hammer**
- **Control of boiler operation**
- **Increased performance for e.g. heat exchangers**

Specification:

- Available for **Prowirl F 200** with Option „Mass flow sensor“ (integrated temperature probe + flow computer) and Option „Wet steam detection“
- Available linesizes: 1“… 12“ (DN25…300)
- Pressure range up to 580 psi (40bar)
- Temperature range +120…250°C

Application Areas

With the following applications the performance of a steam system can be monitored and improved:

- **Steam Generation - Efficiency of a steam boiler**
- **Steam Distribution - Balancing and Leakages of a steam system**
- **Steam Consumption - Heat and specific energy consumption**

Steam Generation - Efficiency of a steam boiler

- Gain transparency of the fuel and steam consumption
- Identify, quantify and allocate losses in the system
- Benchmark boilers, consumers and optimize their use
- Minimize maintenance cost and downtimes
- Verify investments in heat recovery measures
- Evaluate most efficient operation load of boiler and production

Boiler efficiency evaluation methods

- **Direct Method** (or: Input/Output Method)

The actual energy input and output of the boiler are determined by measurement.

$$Direct\ Boiler\ Efficiency = \frac{Boiler\ Output\ (kWh)}{Boiler\ Input\ (kWh)} * 100$$

- **Indirect Method** (or: Heat Loss Method)

The heat balance efficiency measurement method is based on accounting for all the heat losses of the boiler.

$$Indirect\ Boiler\ Efficiency = 100\ - (Stack\ Loss + Radiation\ Loss + Blow\ Down\ Loss)$$

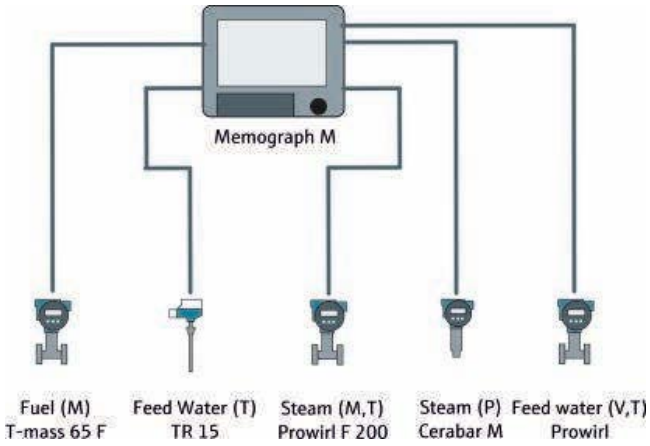
This method is also called ASME heat balance method.

It´s recommendable to start with the direct method as it is the easier and more practical way to calculate the boiler efficiency.

Extended Direct Method

KPI	Boiler Efficiency + Heat Loss Determination (simplified)
Required measures	▪ Fuel mass or corrected volume flow
	▪ Steam volume or mass flow
	▪ Steam temperature and/or pressure
	▪ Feed water temperature
	▪ Feed water volume flow
	▪ Flue gas temperature

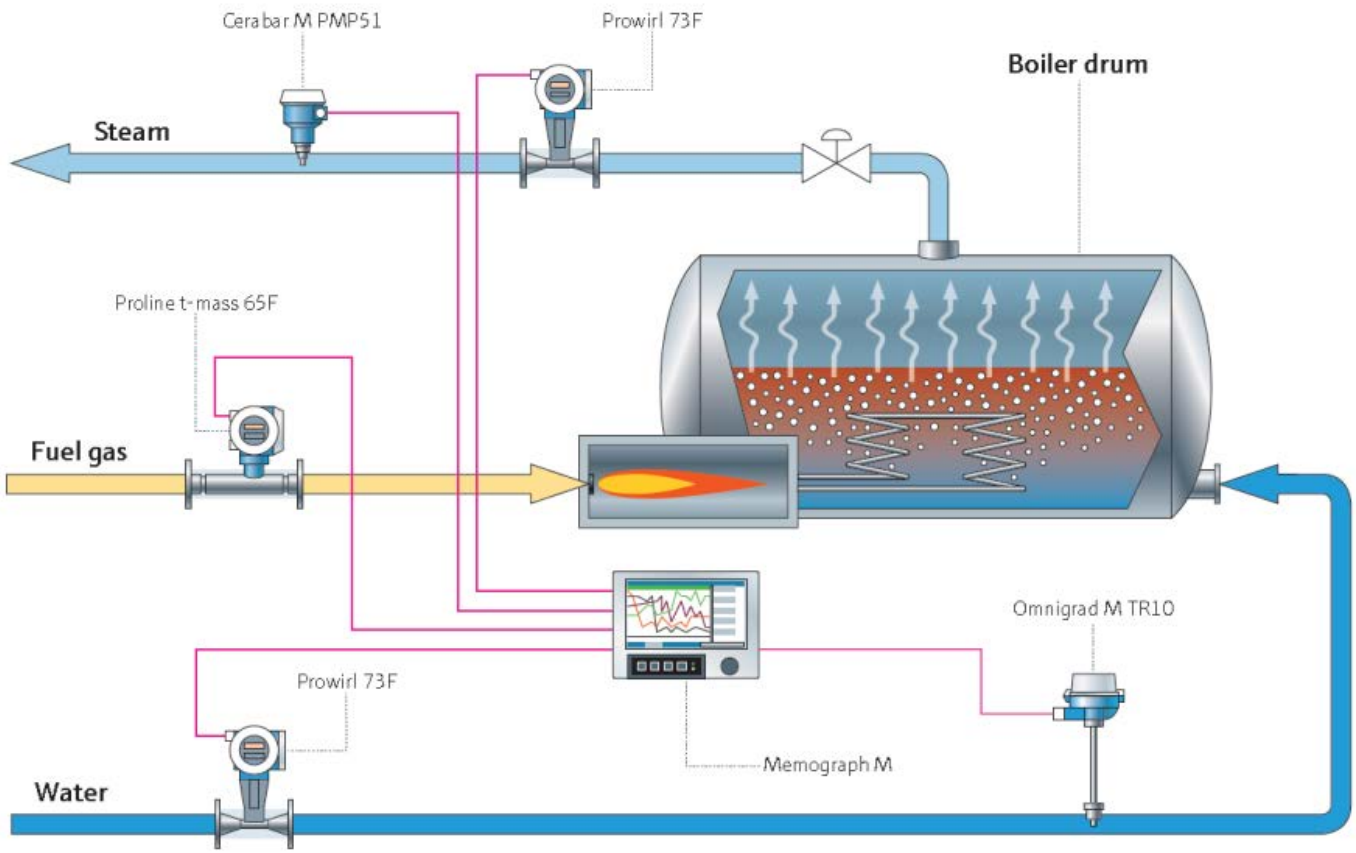
Typical application example:



Blow Down Loss and Flue Gas Loss for Trend Monitoring:

The heat losses of a boiler can be subdivided into stack loss, radiation loss, blowdown loss. Quantifying these losses is helpful for detailed analysis of the individual boiler components and their contribution to overall efficiency. Based on this selective measure for efficiency, improvements can be defined and the success of respective improvements justified.

Typical design of a steam system



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Steam Distribution - Balancing and Leakages

A lot of energy within steam systems is lost due to

- improper insulation
- leakage found at valve stems, unions, pressure regulators, equipment connection flanges, pipe joints or defect steam traps

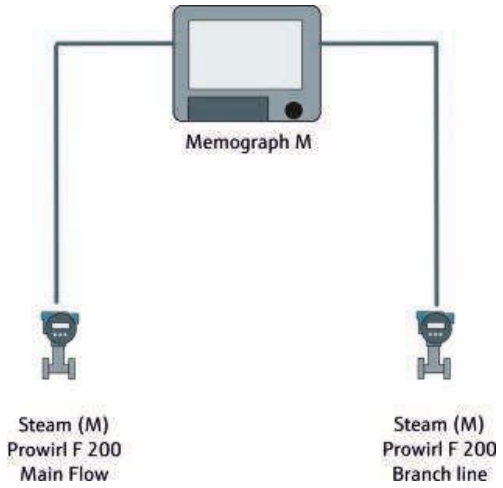
Mass balancing by measurement helps to

- detect leakages in time (not at the end of year or month)
- define ideal maintenance intervals and justify expenses
- find weak points in insulation

Steam Distribution – Balancing and Leakage Calculation

KPI	Steam Balancing, Leakage Calculation
Required measures	▪ Steam mass (main flow)
	▪ Steam mass or volume (in branch line–before heat exchanger) or ▪ Condensate volume (in branch line–after heat exchanger)
	▪ Optional: Make up Water

Typical application example:

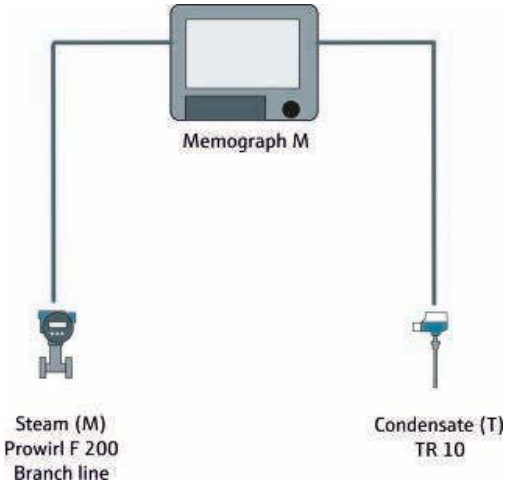


The principle of balancing is helpful to calculate total leakage (by comparing produced and consumed steam) or supervising long pipe sections (insulation, leaks).

Steam Consumption– Heat & Specific Energy Consumption

KPI	Heat consumption, Specific Energy Consumption
Required measures	▪ Steam mass or volume flow (in branch line – before heat exchanger) or ▪ Condensate volume flow (in branch line – after heat exchanger)
	▪ Steam temperature (in branch line – before heat exchanger)
	▪ Steam temperature (in condensate – afterheat exchanger)

Typical application example:



The heat consumption is the “rough” value of heat transfer from steam to a product (e.g. using a heat exchanger). The specific steam consumption value quantify how much energy is transferred to a unit of product (e.g. steam consumption/liter of beer)

Payback-Example

Situation:

- Fire tube Steam Boiler 20 t/h (10 bar)
- Operation: 8000 hours/a
- Steam production costs: 30 €/t

Sources of energy loss:

- Steam loss due to steam trap malfunction: 30 kg/h or 240 t/a per steam trap

  Typically 25 % of steam traps are defect
- Efficiency loss due to scaling of heat transfer surface: 0.5 %

  → 800 t/a steam (Calculation: 0.5% of 20t/h*8,000h/a)

  Typically fouling decreases efficiency by up to 5 %, optimized cleaning interval can improve it

Payback-Example

Payback Calculation:

Investment costs instrumentation Applications: Boiler efficiency + system balancing	12,000 €
Total amount energy losses	1,040 t (800 t/a + 240 t/a)
Steam production costs	30 €/t

Savings:

1,040 t * 30 € = **31,200 €/a** (or 2,600€/month)

The payback period is less than 5 months!

12,000 € : 2,600 € = **4.62 months**

Compressed Air Applications

Application Areas

With the following applications the performance of a compressed air system can be monitored and improved:

- Compressor efficiency (SEC, SPC)
- **Balancing of a compressed air system**
- **Leakage detection in a compressed air system**
- **Filter supervising**
- **Pressure drop supervising**

Leakage detection and balancing

Typical plants have a leakage rate of 20-30% of the total compressed air production capacity. In well maintained systems this loss can be reduced to less than 10%.

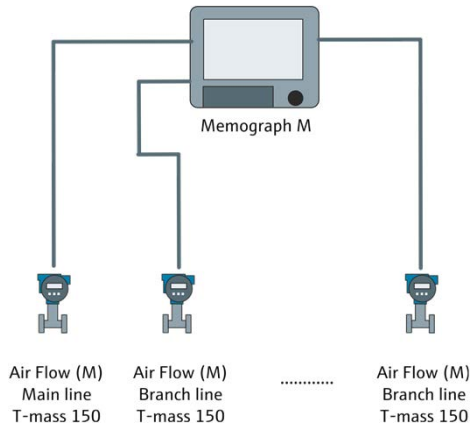
Balancing can be used to calculate leakage loss “in time” and thus

- Detect and repair disruptions or leakages
- Avoid operation loss (pressure drop makes air tools function less efficiently, adversely affecting production)
- Avoid longer compressor runtime and thus lengthen lifetime (for almost all system equipment)
- Reduce maintenance and increased unscheduled downtime
- Avoid adding unnecessary compressor capacity

Air Distribution – Balance and Leakage

KPI	Air balancing, leakage calculation
Required measures	▪ Air mass or standard volume (in main flow)
	▪ Air mass or standard volume (in branch lines)

Typical application example:



The principle of balancing is used to calculate total leakage by comparing produced and (sum of) consumed air or to monitor pipe sections (for leaks, disruption).
Apart from leakage detection this value can be used to verify the quality of measurement (to detect installation problems or meter failure).

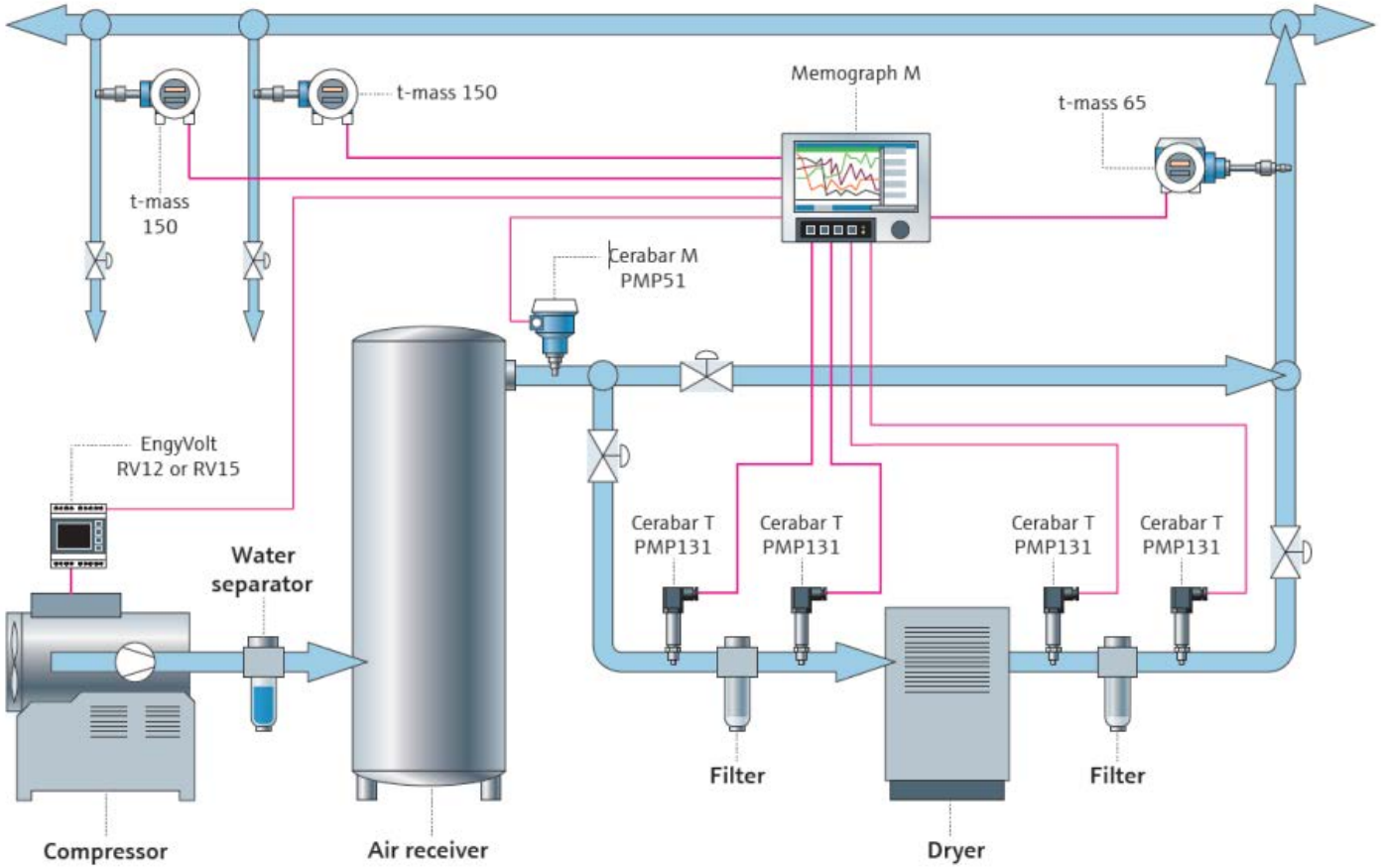
Filter and Pressure Drop Supervising

Another parameter of greatest importance for the compressor and system performance is the pressure. If pressure is reduced by only one bar, energy savings of 10% can be obtained.

Filter and pressure supervising by measuring pressure values at different points across a compressed air system helps to

- Detect filter blockage and exchange filter at an ideal point of time (avoiding pressure/ energy losses),
- Indicate system disruptions and general system conditions.

Typical design of compressed air systems



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Conclusion

- Endress+Hauser can help you to monitor your energy
- Endress+Hauser offers consulting to reduce your energy consumption
- My suggestion: Do it step by step and bottom-up
  - Water, air, gas, electricity and steam
  - Start with the instrumentation, not with a software!
- Smart scale energy solutions give you a fast ROI!