

Focus on industrial utilities

Tailored solutions for improved energy management



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Measuring, monitoring and analysing energy consumption and performance are key factors in ensuring a successful energy management policy. Measuring enables you to determine your significant usages, focus your energy saving efforts, monitor the performance of your installations, and thereby take quick action in the event of any anomalies.

Endress+Hauser is firmly focused on the measurement of industrial utilities and the insights their data can provide. Our energy experts are able to offer you the best advice so that you can adopt a turnkey measurement plan, including reliable industrial measuring instruments, open energy management solutions and the right metrological monitoring - all tailored to your requirements. This brochure offers an overview of our expertise in the deployment of measuring solutions for compressed air plants, steam heating plants, refrigeration systems and heat exchangers. Choose Endress+Hauser and gain control of your energy savings project.

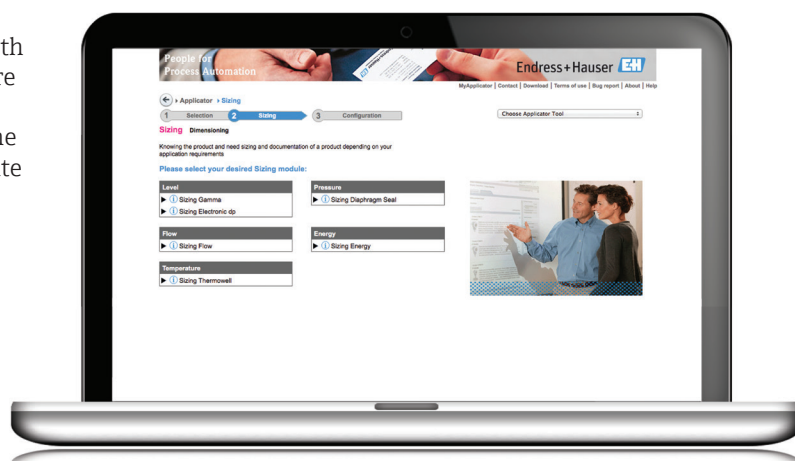
Applicator, a unique tool for sizing instruments and calculating uncertainty in the energy loop

What measuring technologies should be used for the different utilities? What is the uncertainty associated with a thermal output determined using flow and temperature measurements?

Check out the Endress+Hauser Applicator, the free online engineering software to help you select, size and calculate the overall uncertainty of an energy loop.



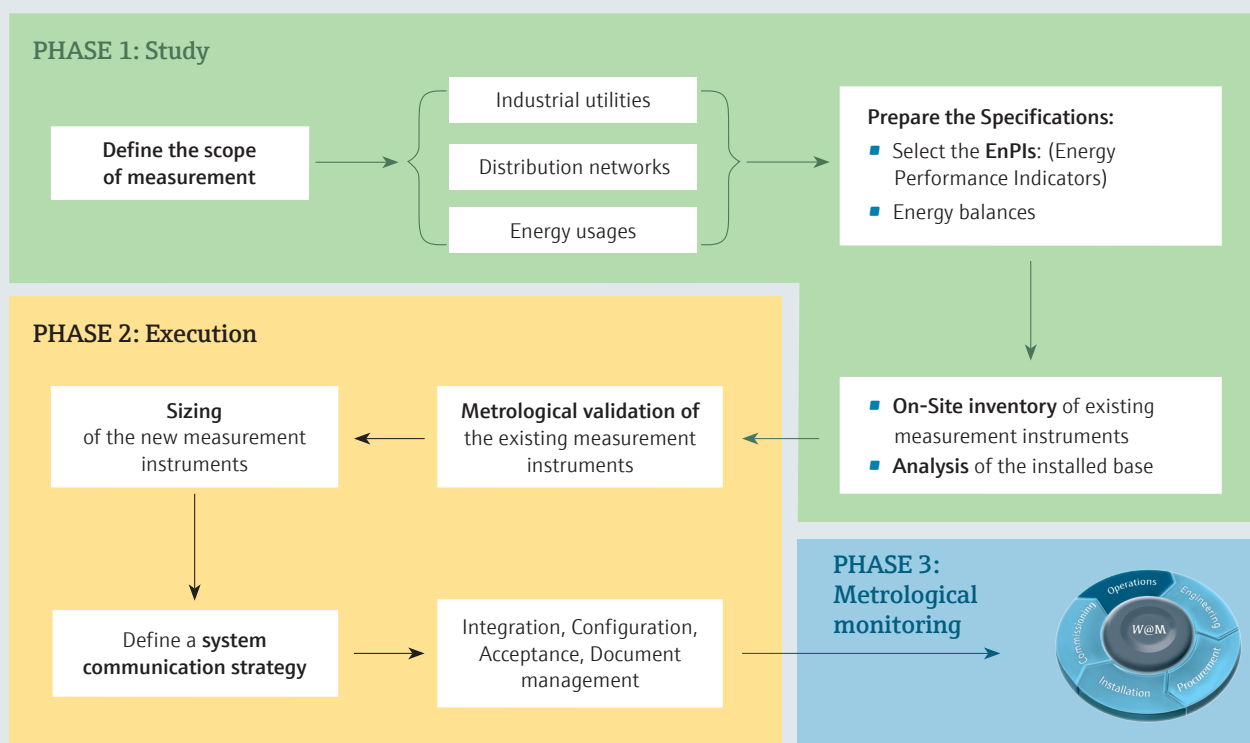
Energy Sizing Applicator



Measuring is important, but measuring accurately is crucial

For companies, lowering energy consumption provides a crucial competitive edge. There are many ways to save, particularly in compressed air, refrigeration and steam generation applications. Despite this, most companies are still not aware of the level of energy losses they incur every day, often due to a lack of visibility or quantification or, quite simply, a lack of measurement.

The measurement plan: the methodology at the heart of ISO 50001



The measurement plan: best industry practice guaranteed

Incorrectly sized measurement instruments, unsuitable installations, poorly configured energy loops - these are all frequently encountered problems. And whenever any doubt sets in, the entire energy management policy can often be called into question.

To ensure global control of energy, not just in terms of utilities, but also of distribution networks and the manufacturing process, Endress+Hauser will help you design and execute your measurement plan project, including all of the following: creating energy reports, determining 'tailor-made' performance indicators,

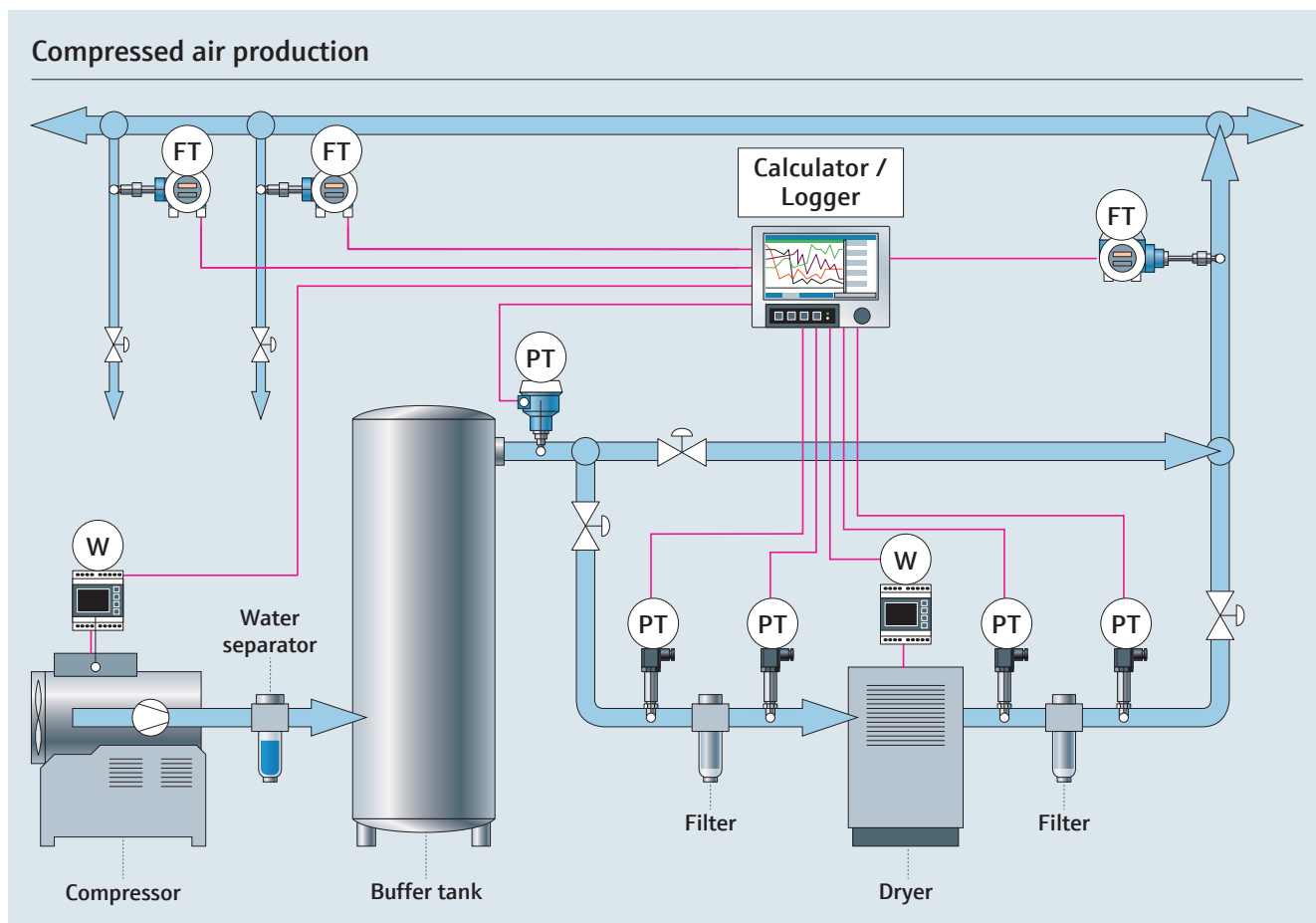
validating the metrology of existing measurement instruments, sizing new measurement instruments, studying the data communication and acquisition modes, and configuring the energy management software tool within the process instrumentation environment.

Endress+Hauser will help you meet the measurement and verification principles required by ISO 50015, in line with the technical and economic constraints of the industry:

- Appropriate accuracy and management of uncertainty.
- Transparency and reproducibility of measurement and verification processes.
- Data management and measurement planning.

Monitoring the energy performance of compressed air plants

In general, compressed air represents 10 to 15% of a company's electricity bill while, on average, 30% of the air produced is lost through leakage! The energy performance indicator to be monitored is the specific energy consumption (SEC) of the compressors (kWh/Sm^3). For large installations which include multiple branched systems, monitoring consumption on each line and any developing leaks is key to achieving savings of between 15 and 30%.



Simplified diagram of a compressed air system

Compressed air adapted instrumentation

Measuring the air flow rate at the plant outlet enables changes in overall production and consumption per station to be monitored in large installations. Thermal mass and vortex measurement technologies can be assessed based on the air quality. A third solution, measured using Aptiflow via a pitot tube or orifice plate, may be contemplated in the case of shorter straight lengths, but attention must be paid to pressure losses!

Dry air flow rate measurement with t-mass 150/65

Thermal mass flowmeter

- Direct measurement of the standardised volumetric or mass flow rate (Sm^3/h)
- Negligible pressure loss, unlike with mechanical flowmeters
- High rangeability, perfect for eliminating leaks
- Insertable version, avoids the need for plant shutdown and increased mechanical pipework costs



Select your thermal mass flowmeter here:

www.endress.com/thermal-mass-flowmeters



Non-dry and non-filtered air flow rate measurement by Prowirl 200

Vortex flowmeter

- Lifetime calibration factor
- Negligible pressure losses
- Requires temperature and pressure compensation when calculating the mass or standardised volumetric flow rate



Select your vortex flowmeter here:

www.endress.com/vortex-flowmeters

Cerabar T/M pressure sensor

Each unused bar of pressure supplied by the installation increases costs by around 6 to 10%. Furthermore, the specific electricity consumption (kWh/Sm^3) must be monitored in correlation with the pressure at the plant outlet.

- Cerabar M for monitoring pressure supplied by the plant
- Cerabar T for monitoring filter fouling levels



Select your Cerabar here:

www.endress.com/absolute-gauge-pressure



Memograph M RSG45 combined flow computer, gateway and logger

For monitoring of the plant and distribution network

- Customised overview of the installation
- Display and logging of performance and consumption levels
- Alarm management
- Communication gateway allows HART-Modbus TCP plus many more



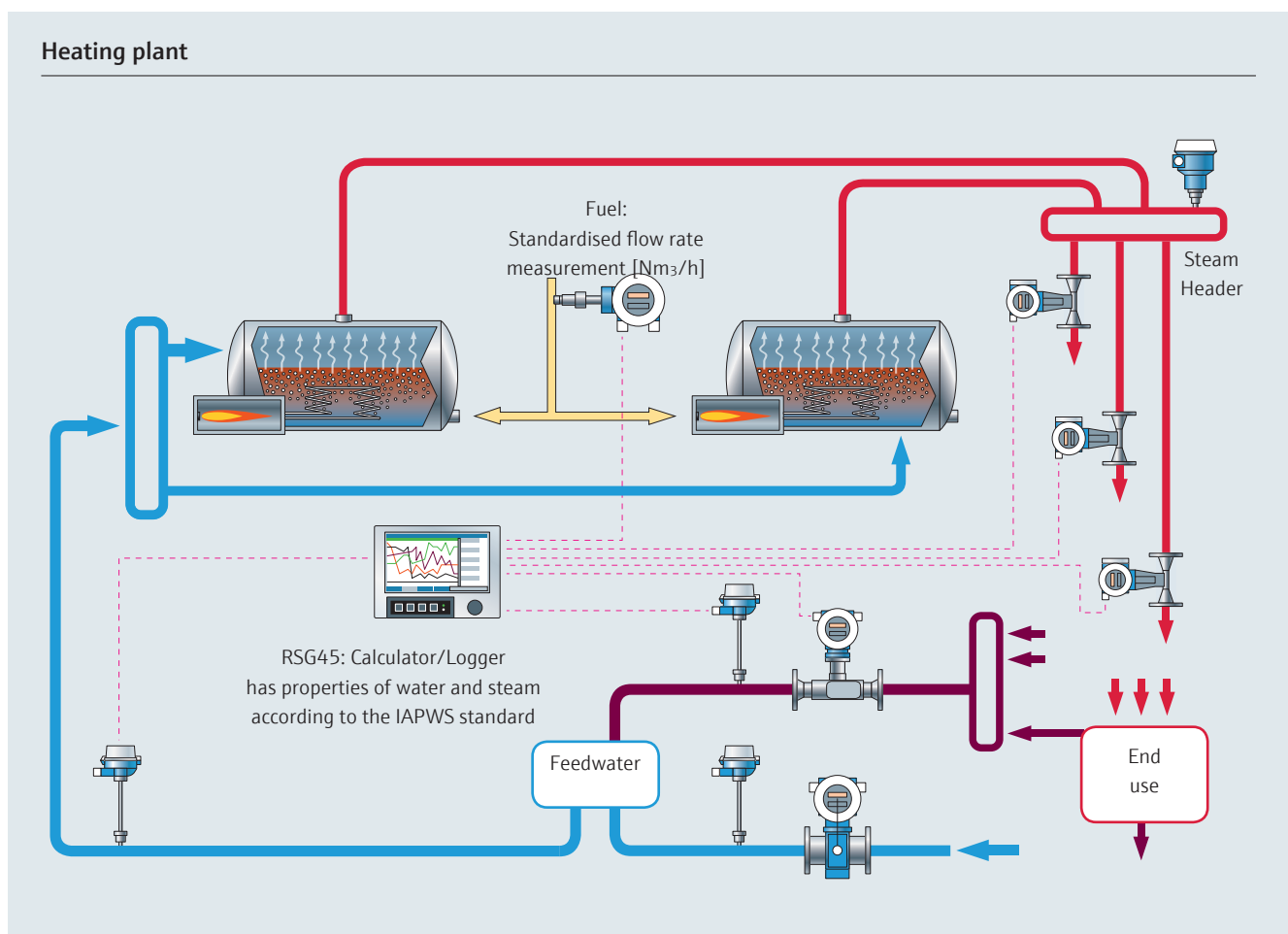
Visit the Memograph here:

www.endress.com/rsg45

Monitoring the energy performance of a heating plant

Whether used for process applications (sterilisation, pasteurisation, curing, drying, etc.) or atmospheric conditioning (heating, humidification, etc.), steam remains one of the most costly fluids to produce in terms of energy consumption, essentially due to the fuel, water treatment and maintenance of equipment it requires. Generally speaking, 40% of the industry's fuel consumption is used to produce heat transfer fluids.

When looking to manage energy consumption, simply metering of water and fuel consumption, whilst useful for accounting purposes, is not sufficient in itself. Tracking the Energy Performance Indicators (EnPIs) for the heating plant and, where applicable, for boilers means that the thermal output is measured, along with the efficiency of the boilers and the heating plant.



Simplified diagram of a steam heating plant

Steam adapted instrumentation

Measuring the steam flow rate can be useful in a range of applications: monitoring the generation of each boiler, determining steam consumption and associated fuel used for energy accountable centres (breakdown of costs, invoicing, etc.), and calculating the efficiency of a boiler or of a heating plant. This measurement is combined with a temperature and/or pressure measurement which is used to determine the energy stored in the steam and thereby calculate the associated thermal output.

Saturated or superheated steam flow rate measurement. Vortex flowmeter: Prowirl 200

In an innovative world first, this flowmeter can now measure not only the steam mass flow rate and thermal output at the boiler outlet, but also the actual quality of the steam itself.

- Lifetime calibration factor
- Negligible pressure losses
- Wide measurement rangeability



Select your vortex flowmeter here:
www.endress.com/vortex-flowmeters



Saturated or superheated steam flow rate measurement. Aptiflow flowmeter: DP flow Solutions with Deltabar

Large choice of pressure reduction components (diaphragm, venturi nozzle, venturi or averaging pitot probe) to allow adaptation to the process constraints (low pressure loss) and installation constraints (shorter straight lengths)

- Recognised, standardised technology (ISO5167)
- Replacement or recalibration of the Aptiflow without system shutdown
- Adapted to extreme process conditions (<420 bar)



Select your DP flowmeter here:
www.endress.com/differential-pressure



Cerabar M absolute pressure transmitter

Equipped with a shut-off valve and siphon.

- 4...20mA or 4...20mA Hart output
- Measurement uncertainty 0.15% or 0.075%
- Simple to commission via the display, with no configuration tool needed for the HART version



Select your Cerabar here:
www.endress.com/absolute-gauge-pressure



Omnigrad TR10/15/88 temperature probe

With pocket and welded, screw-in or flanged connection.

- Modular construction
- Pt100 signal, with or without transmitter or display, head-mounted or separate



Select your temperature probe here:
www.endress.com/compact-thermometers



Calculating mass flow rate, thermal output or cumulative energy

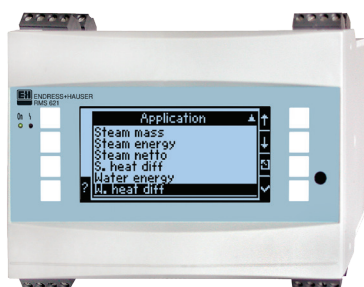
Single stream EngyCal RS33, and multistream RMS621 or Memograph RSG45 energy calculators

The calculator uses the flow rate, temperature and/or pressure information to calculate the thermal output and the cumulative energy of an industrial fluid.

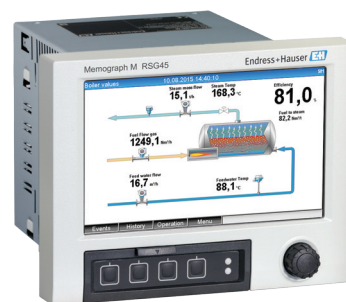
- Calculation standard as per IAPWS-97 (International Association for the Properties of Water and Steam)
- Flow rate measurement compensation for DP flow technologies
- Digital output (Ethernet TCP/IP, Modbus TCP/RTU, M-Bus, Profibus) to connect to our platforms and/or other platforms



EngyCal RS33



RMS621



Memograph RSG45

Visit the RS33 here:
www.endress.com/rs33

Visit the RMS621 here:
www.endress.com/RMS621

Visit the Memograph here:
www.endress.com/rsg45

Instrumentation adapted to fuel measurement

Fuel flow rate measurement is also an important part of calculating boiler efficiency. It is essential to have the right heating value for the fuel net CV (NCV or LHV) or gross CV (GCV or HHV) to perform this calculation.

Gas flow rate measurement Thermal flowmeter: t-mass 65

For direct measurement of mass, standardised volume and output

- Very low pressure loss
- Rangeability 1/100
- Insertable version or version mounted between flanges



Select your thermal mass flowmeter here:
www.endress.com/thermal-mass-flowmeters

Fuel oil flow rate measurement Coriolis flowmeter: Promass E

For mass measurement

- No straight lengths required
- Very high precision (< 0.2 %)
- Rangeability 1/1000
- Independent of viscosity



Select your Promass E here:
www.endress.com/Coriolis-mass-flowmeters

Instrumentation adapted to heat transfer fluids

To calculate the boiler efficiency, the thermal output of the feedwater is taken into account by measuring the temperature and flow rate. To calculate the overall efficiency of the heating system, the thermal output of the condensate returns and that of the make-up water are also required.

Ultrasonic flowmeter: Prosonic Flow 92F

For volumetric measurement of conductive or non-conductive hot fluids

- No pressure loss, full flow-through
- Very good rangeability 1000/1
- Also comes in a clamp-on version for external mounting (91W)



Visit the Prosonic Flow 92F here:

www.endress.com/92F



Electromagnetic flowmeter: Promag 10/400

For volumetric measurement of conductive fluids

- Excellent price/performance ratio
- No pressure loss, full flow-through
- High precision (< 0.5 %)
- Wide rangeability



Select your electromagnetic flowmeter here:

www.endress.com/electromagnetic-flowmeters

Temperature probe: Omnigrad TR10/TST90

For measuring liquid temperatures

- Modular construction (choice for process connection, extension and insertion lengths, guard diameter, etc.)
- Pt100 signal, with or without transmitter or display, head-mounted or separate



Select your temperature probe here:

www.endress.com/compact-thermometers



Ultrasonic flowmeter: Prosonic Flow E 100

Economical Ultrasonic flowmeter with integrated temperature measurement

- Reducing further measuring point – multivariable device
- Dependable flow measurement – high turndown (200:1)
- Extended calibration intervals – integrated device verification due to Heartbeat Technology



Visit the Prosonic Flow E 100 here:

www.endress.com/9E1B



EngyCal RH33 energy meter

For calculating the direct or differential thermal output of a liquid fluid

- Electronic pairing of 2 Callendar van Dusen temperature probes excellent precision (< 0.025°CVD); a single probe can be replaced if broken
- MID version for compliance to RHI and Heat Network (metering & billing) regulations
- Ethernet, Modbus TCP/RTU and M-Bus output



Visit the RS33 here:

www.endress.com/rs33

Analysis panels for continuously checking water quality

In energy production plants, water quality is a key factor in both the management and the safety of the installation as a whole. The water/steam cycle must be free from all contamination to prevent corrosion of the turbines and ducts, which can lead to costly repairs or to the need for complete replacement of some equipment. Continuously measuring the physical and chemical parameters means the right decisions can be taken in terms of process management.



Endress+Hauser offers a smart solution for monitoring the water/steam cycle

- Flexible engineering: each panel is adapted to the configuration of the industrial site, providing a turnkey solution which will minimise installation costs.
- Optimised instrumentation: specialist analytical devices designed to reduce maintenance costs by limiting the installation downtime, helping you to extend the service life of your equipment.
- Complete documentation for managing your installed base.
- Integration of the system using a certified communication protocol.
- A unique partner for a comprehensive offering: instrumentation, engineering, commissioning and maintenance.

Physical and chemical analysis parameters for boiler water/condensates

- The quality of the demineralised water used in energy production plants depends on a number of parameters: pH, oxygen, conductivity, hardness, silica and sodium.
- Our instrumentation uses inline sensors, based on the digital Memosens technology, ensuring signal transmission without interference and optimising maintenance.
- The feedwater sample passes via a cooling system, then a pressure reduction device, before being sent to sensors fitted in specific flow-through chambers.



Conductivity: a key parameter

The conductivity measurement provides information on water contamination; it can be determined in one of several ways:

- Total (or specific) conductivity: measuring the water purity. A sudden increase in the total conductivity indicates a leak in the demineralisation system or in the boiler.
- Cation conductivity (or acid conductivity): all cationic impurities are transformed into highly conductive acid in the cation exchanger installed on the board, enabling any increase in impurities in the sample to be quickly detected.
- Differential conductivity: indicates the concentration of alkali in ultrapure water. This figure is used to calculate and adjust the pH value.
- Degassed conductivity: detecting the presence of carbon dioxide, caused by a condensate leak.

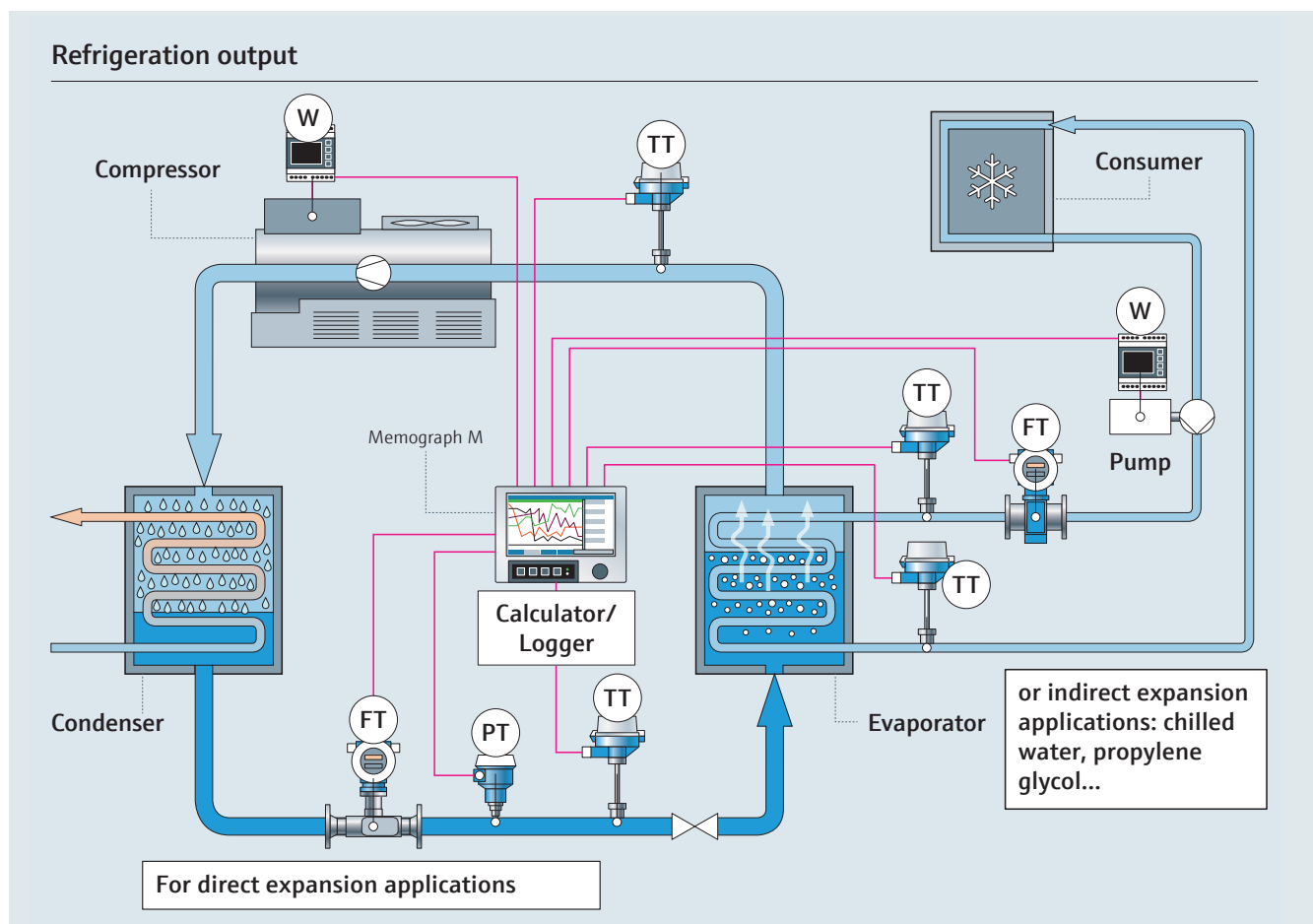
Endress+Hauser Energy panels help you protect your installation against damage and ensure a long service life. Our panels are used on a wide range of applications, but remain individual solutions. They are designed by our engineering experts to meet your specific conditions.



Monitoring the energy performance of refrigeration plants

In industry, approximately 10% of electricity consumption relates to refrigeration output - in breweries this can be up to 30%. Whether this is for process applications (freezer units, cooling tunnels, warehousing, etc.) or atmospheric conditioning (cooling, dehumidification, etc.), refrigeration remains one of the industrial utilities which requires the most technical skill, due to the different modes of refrigeration output (direct or indirect expansion) and the various possible installation layouts.

When looking to manage energy consumption, simply metering electrical output, whilst useful for accounting purposes, is not sufficient in itself. Tracking the Energy Performance Indicators (EnPIs) of the refrigeration plant means that the cooling output is measured, along with the installation's coefficient of performance (COP).



Simplified diagram of a refrigeration plant

Instrumentation adapted to refrigerants

For an installation using direct expansion (NH_3 , CO_2 , etc.), calculating its cooling output and coefficient of performance (COP) requires measurement of pressure, temperature, electrical outputs and flow rates. The flow rate can be measured on the gas or liquid side; see below for the preferred technologies. Measurements must not be taken in positions where there may be a two-phase flow regime (presence of liquid in gas or vice versa).

Ultrasonic flowmeter: Prosonic Flow 91W

For volumetric measurement of liquids

- Unobtrusive technology; can be installed without shutting down the installation
- Monitors trouble-free operation on-site
- No pressure loss

Visit the Prosonic Flow 91W here:
www.endress.com/91W



Vortex flowmeter: Prowirl 200

For volumetric measurement of liquids and gases

- Lifetime calibration factor
- Negligible pressure loss
- Robust - not affected by water hammer/vibrations

Select your vortex flowmeter here:
www.endress.com/vortex-flowmeters



Instrumentation adapted to coolants

For a system using chilled water, glycol water, etc., calculating the installation's cooling output and coefficient of performance (COP) requires measurement of pressure, temperature, electrical outputs and flow rates; the preferred technology for this essentially depends on the conductivity of the fluid. In addition to electromagnetic and Aptiflow flowmeters, details of the vortex flowmeter can be found on page 13.



Electromagnetic flowmeter: Promag 10/400

For volumetric measurement of fluids with conductivity $> 50 \mu\text{S/cm}$ or $5 \mu\text{S/cm}$ with the Promag 400.

- Full flow-through, no pressure loss
- Wide rangeability 1000/1



Select your electromagnetic flowmeter here:
www.endress.com/electromagnetic-flowmeters

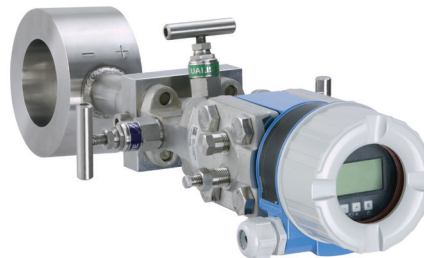
Aptiflow flowmeter: Deltatop

For volumetric measurement of all coolants

- Can be calibrated without shutting down the installation
- Easy to adapt to the existing installation



Select your dp flowmeter here:
www.endress.com/differential-pressure



For calculating the cooling output and COP

Endress+Hauser offers different types of calculators for monitoring one or more applications with easy integrability. For more information, please refer to pages 8 and 9.



Omnigrad TST90/TR10 temperature probes

For differential temperature measurement

- Mechanically paired probes with uncertainty $< 0.05^\circ\text{C}$ or electrically paired probes (Callendar-Van-Dusen coefficients) with uncertainty $< 0.025^\circ\text{C}$
- Fast response time with reduced tip



Select your temperature probe here:
www.endress.com/compact-thermometers



Cerabar T/M pressure sensor

- Different membrane materials (stainless steel, alloy, etc.)
- Fixed or configurable measurement scale
- Version with display



Select your Cerabar here:
www.endress.com/absolute-gauge-pressure

Energy Performance Indicator: from measurement to metrology

A high-performance measurement system, is an essential tool for managing the preventive maintenance of industrial utilities. This maintenance strategy remains one of the key factors giving industrial companies their competitive edge. The Energy Performance Indicators (EnPIs) are at the heart of this strategy, enabling the energy performance of one item or set of equipment to be characterised, and the sources of a failure to be diagnosed and analysed, thereby allowing potential areas of improvement to be identified. To meet this requirement, which is of critical importance to maintenance engineers, and taking the Energy Management reference standards – ISO 50001 and ISO 50006 – as its guide, Endress+Hauser is the sole instrumentation and metrology provider to have developed a catalog of EnPIs specific to industrial utilities:

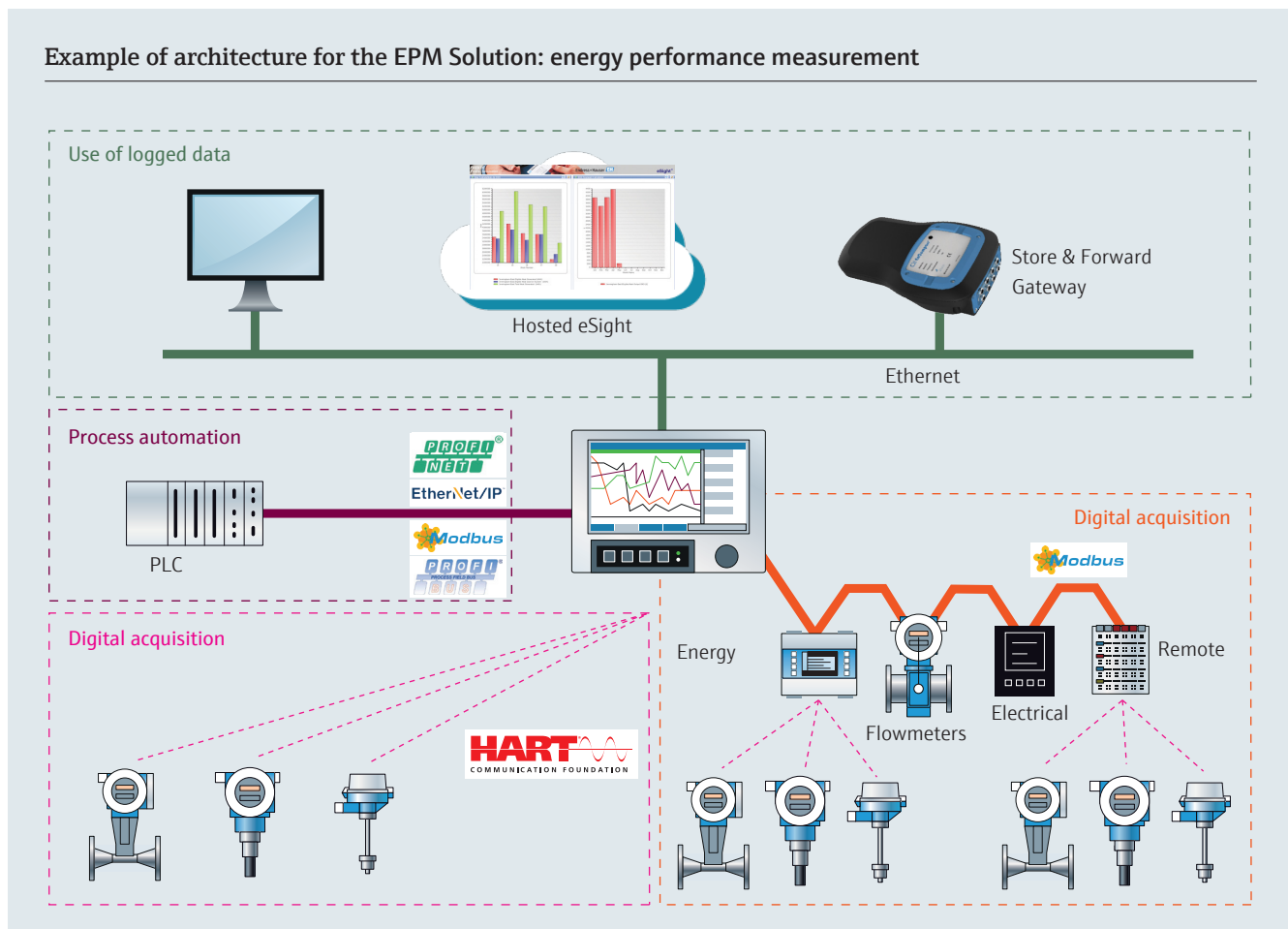
Type of EnPIs as per: ISO 50001 & ISO 50006		Compressed air plant	Hot water or Steam heating plant		Refrigeration plant	Heat exchanger
			Boiler	Heating plant		
				Page 4 and 5	Page 6, 7, 8, 9, 10 and 11	
Output	Electrical [kW]	x			x	
	Thermal [kW]		x		x	x
Specific ratio	Name	Specific energy consumption	Blow down	Condensate return	Coefficient of performance	
	Unit	kWh/Sm³	[-] %	[-] %	kWhrefri/ kWhelec	
	Measurement range	[0 ... 200]	[0 ... 100 %]	[0 ... 100 %]	[0 ... 10]	
	Uncertainty calculation	x	x	x	x	
	Metrological monitoring	x	x	x	x	
Efficiency	Name		Fuel to steam efficiency	Boiler house efficiency		
	Unit		[-] %	[-] %		
	Measurement range		[0 ... 100 %]	[0 ... 100 %]		
	Uncertainty calculation		x	x		
	Metrological monitoring		x	x		
Energy coefficient	Name					Heat transfer coefficient
	Unit					W/Cm²k
	Measurement range					[0 ... 5000]
	Uncertainty calculation					x
	Metrological monitoring					x

ISO 50006: Energy management systems - Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI) -

Open communication solutions

Measurement should lead toward a decision. Ensuring all measured data is automatically collected is a crucial step. In our Projects units worldwide we have certified communication network experts able to offer you advice on how to ensure your project is a success.

Example of architecture for the EPM Solution: energy performance measurement



- The values measured are sent back from the field to a Memograph RSG45 logger/calculator in a number of different ways
 - Standard Modbus communication protocol
 - Using a purely analog connection (4-20 mA)
 - Using the instrument's HART signal (multiparameter)
- Real-time data transmission to an automated system via industrial communication protocols such as Modbus, Profibus, Ethernet IP, and Profinet
- This acquisition system also allows the process values to be shared with other systems or platforms either on premises or in the cloud

Display and recording solutions

For a successful energy management policy, it is essential that an energy consumption and performance measurement system is put in place. Amongst other benefits, this ensures real-time monitoring of significant energy usages, display of the EnPIs and evaluation of actual energy performance in relation to a reference state. The savings generated by this type of remote energy management solution are estimated at between 5 and 15%.

Memograph RSG45 calculator/logger: the field solution

- Real-time monitoring of the consumption and performance of one or more installations
- Customised overview
- Energy calculation and data logging
- Option for automated transfer to higher-level systems
- Can pass the data onto multiple platforms
- Gateway for centralised maintenance of the measurement instruments
- Integrated web server for configuration and display



Visit the Memograph here:
www.endress.com/rsg45



eSight software suite: the solution for Energy Managers

- All energy consumption for one or more sites centralised at a single point
- Online or permanently installed software suite, multi-user access.
- The perfect solution for structuring and applying an energy policy
- A variety of tools for setting targets and objectives, editing reports, managing alarms and identifying ways to save



Visit the eSight software here:
www.endress.com/esight



Guiding you to long-term savings

The Endress+Hauser Service department has a unique presence in the field, managing several thousand maintenance and calibration contracts. Endress+Hauser is your guarantee:

- of comprehensive commissioning of instruments, monitoring of all data, providing an accurate Energy Performance Indicator reading.
- that your existing measuring devices, regardless of the brand, supply data that is accurate and repeatable over time.
- that the calibration logs and other methods used to determine accuracy and repeatability are retained.
- of on-site technical support and training.



Endress+Hauser Service

- Technical support
- Diagnostics and repairs
- Engineering
- Commissioning
- Calibration
- Maintenance
- Training
- Energy Services Consultancy

Focus on a service: Validating the steam energy measurement

You need to prove the energy performance of a system in order to meet compliance standards such as Renewable Heat Incentive (RHI), Combined Heat and Power Quality Assurance (CHPQA) or receive incentives, or ensure the accuracy of your billing transactions. With the steam energy measurement validation service, you get:

- calibration or checking of each component in the measurement chain (flow rate, pressure, temperature and calculator).
- calculation of the energy values, with the associated uncertainty, as per the international standard IAPWS-IF97.
- the contribution of each parameter to the overall measurement uncertainty.
- identification of corrective actions and means of improvement.

W@M-Life Cycle Management: a practical tool for quick access to measurement instrument data

W@M-Life Cycle Management: a practical tool for quick access to measurement instrument data.

Full traceability of all information relating to your measurement instruments (commissioning report, calibration certificates, etc.), accessible 24/7.

All the information needed for conducting an ISO50001 audit.



A single contact for managing your energy saving projects



Endress+Hauser provides referenced methods and practical tools to enable you to best manage your energy saving projects and ensure the associated measurements remain stable and reliable over time. A comprehensive approach encompassing instrumentation, engineering solutions and service provision. The expertise acquired over the last 60 years by Endress+Hauser in measurement, communication networks, data analysis systems and metrology services is your guarantee of the right solution, both in technical and economic terms.

Our Energy Team will offer you guidance throughout your project:

- Methodology based on our experience and the standards ISO 50001 and ISO 50015 (Energy Management Systems).
- Identification of measurement points and advice to enable you to set up robust, reliable and accurate measuring instruments, without resorting to undesirable technical compromises.
- Monitoring and recording of consumption and energy performance as part of an open solution.
- Commissioning and verification of the entire system (unit measurement, measurement loop, EnPI), training of personnel.
- Metrological monitoring to ensure long-term savings.
- Consultancy services to ensure compliance to legislation or regulations.

