

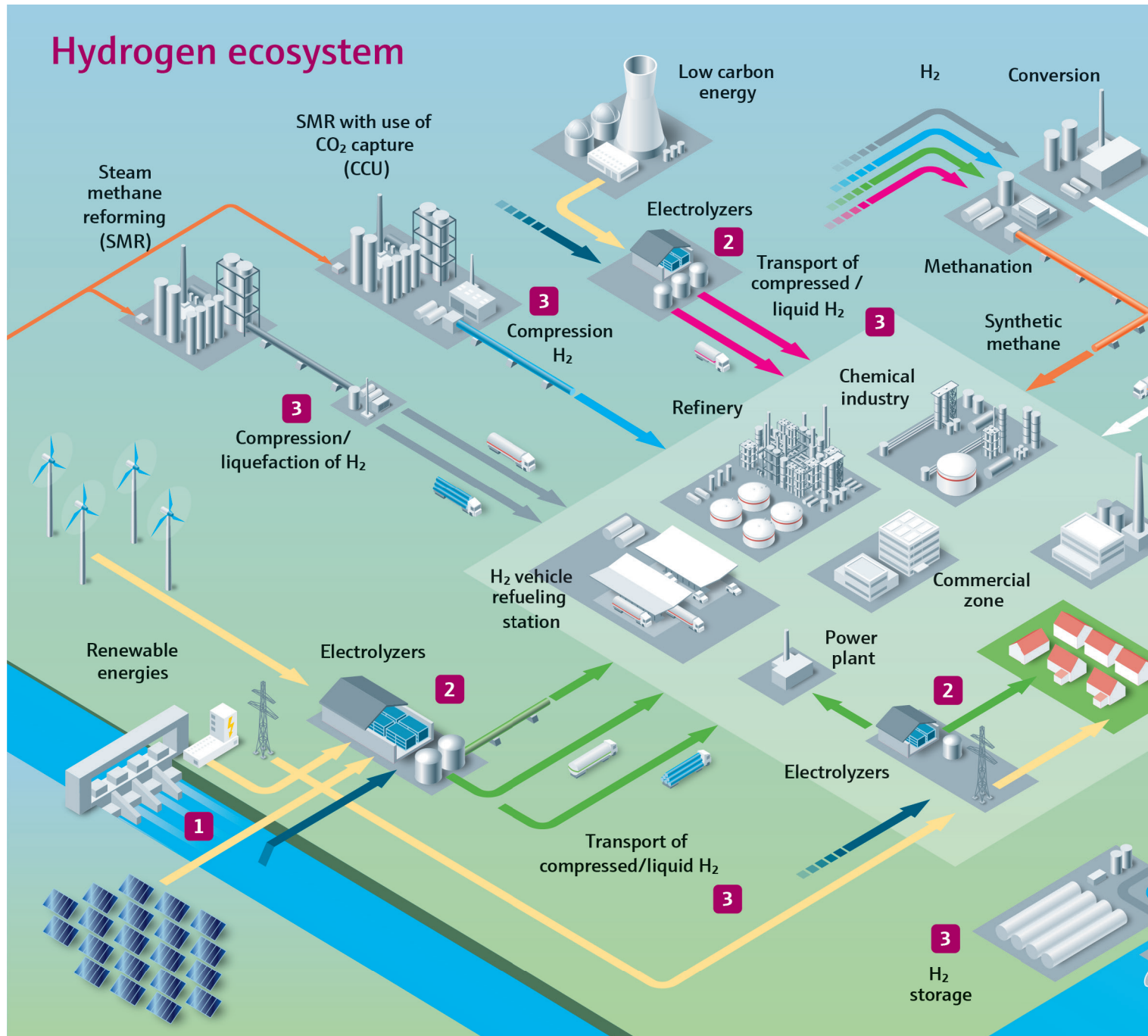
## Supporting the hydrogen economy

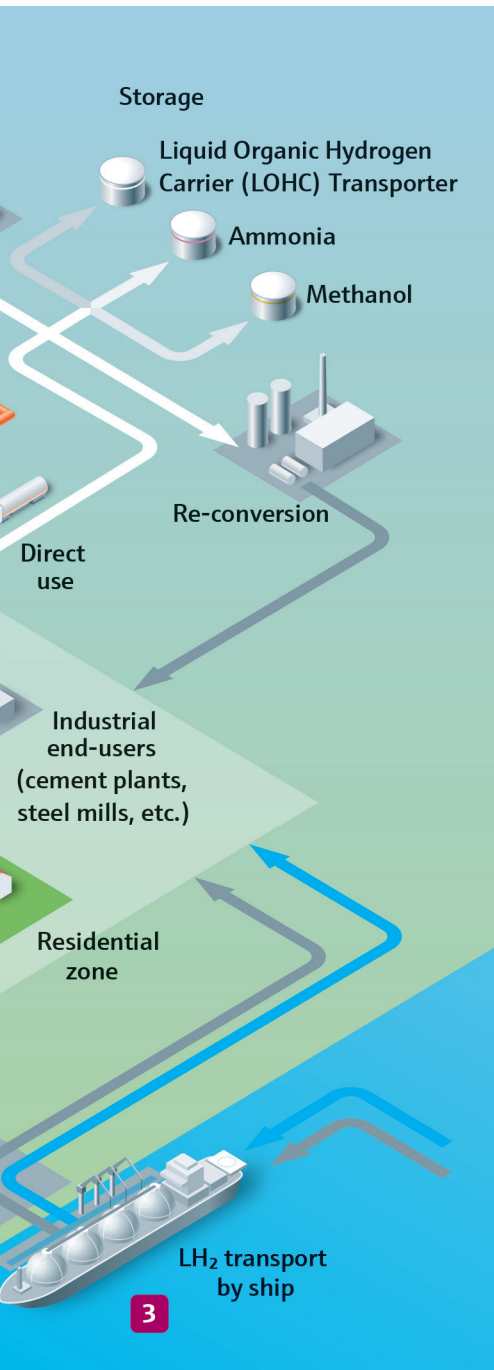
Products, services and solutions to  
enhance the reliability and security  
of the entire H<sub>2</sub> value chain



# Endress+Hauser expertise serving the energy transition

Drawing on years of experience in instrumentation, Endress+Hauser offers a comprehensive range of solutions across the entire value chain of hydrogen.





**Optimize your performance**

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**Secure your processes**

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- 6. Cybersecurity ..... p. 13

**Modernize your plant**

- 7. Digitalization ..... p. 14
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**Services**

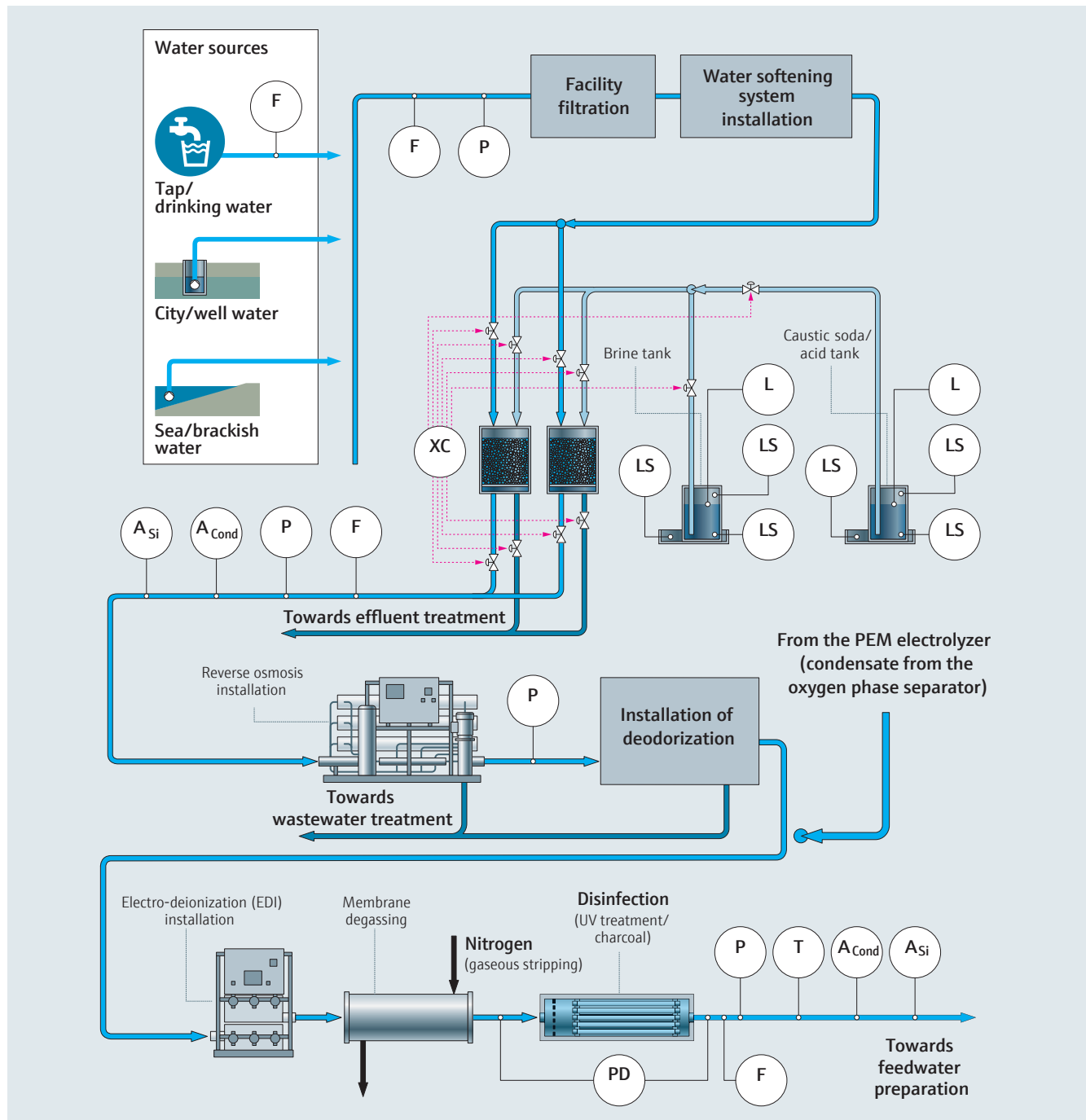
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# Water preparation

One of the most critical steps for electrolysis is the water preparation to a particular quality specification, which varies for different types of electrolyzer technology.

It is essential to measure the following parameters: level, flow, pressure, conductivity, and in some cases pH. As green hydrogen facilities scale up, TOC may be another parameter to quickly detect failures in upstream

treatment that would not be caught by conductivity or pH. Endress+Hauser, with its expertise and platform for liquid analysis, addresses all your needs and increases ease of maintenance, ensuring more uptime.





### Electromagnetic flow measurement – Promag W 10

Flowmeter used for monitoring conductive liquids. The world's first electromagnetic flowmeter for unrestricted installation measurements.

- Version 0 x DN with full bore: without any upstream or downstream lengths and no pressure loss
- Easy commissioning: thanks to the touchscreen via smartphones using Bluetooth® with the SmartBlue app
- High rangeability and measurement precision
- Embedded Heartbeat Technology for simplified operational performance monitoring



### Relative pressure measurement – Cerabar PMP51B

Reliable and easy-to-use sensor for monitoring and tracking pressure in pipelines.

- Measuring accuracy up to +/- 0.055%
- Excellent reproducibility and long-term stability
- Easy and remote commissioning via smartphone using the SmartBlue app
- Guided SIL commissioning to streamline safety in the field



### Conductivity measurement – CLS16E with transmitter Liquiline CM442

Conductivity measurement on ultra-pure water for PEM electrolyzers and on potassium for alkaline electrolysis, for optimal quality monitoring.

- Wide measuring range
- Compact design for simplified installation
- Memosens 2.0 technology with data storage and contactless transmission



### Differential pressure measurement – Deltabar PMD55B

Differential pressure transmitter known for its robustness and reliability, enabling the monitoring of filtration quality throughout the water treatment process.

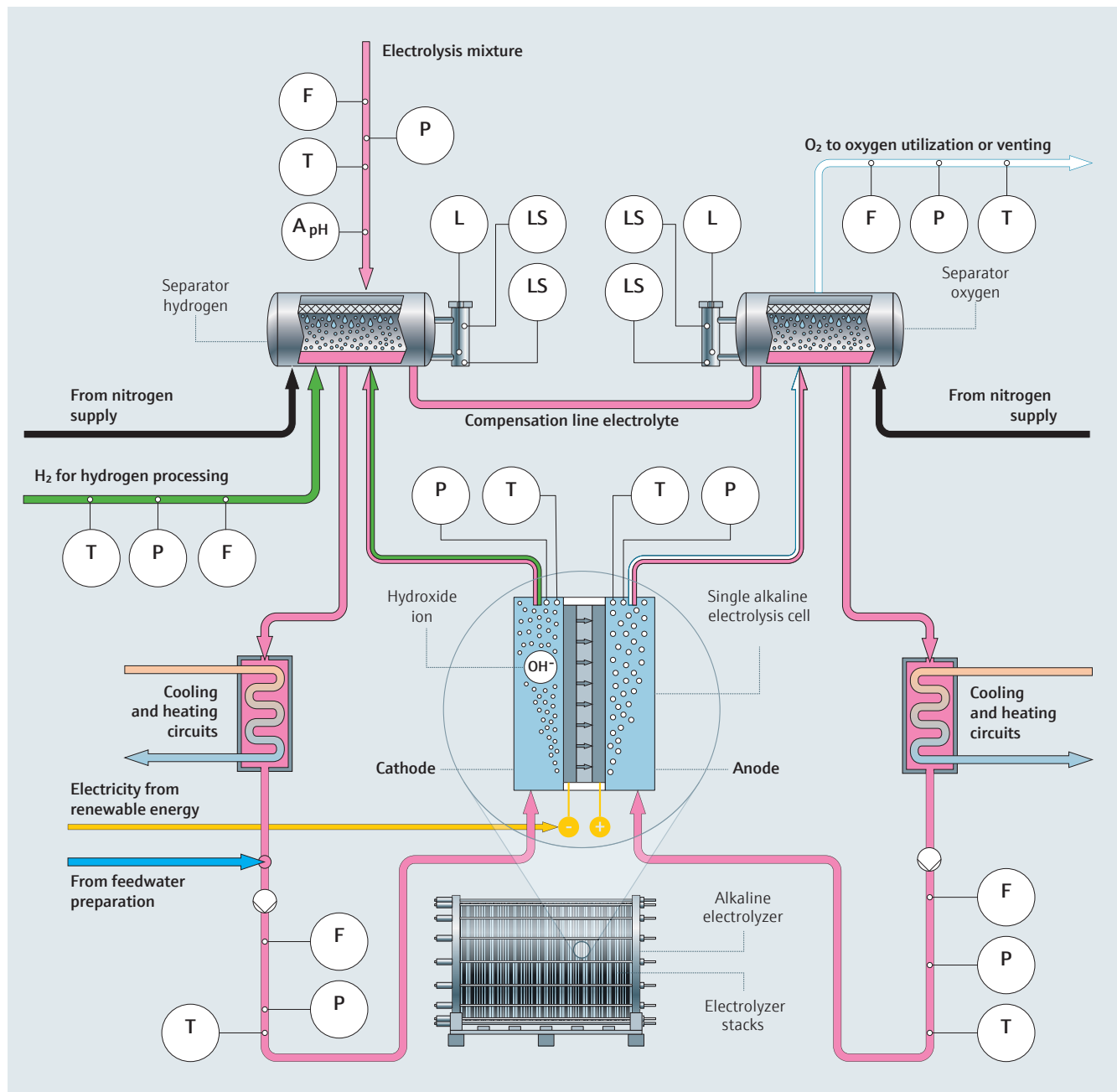
- Measuring accuracy up to +/- 0.055%
- Compatible with smartphones through secure Bluetooth connection using the SmartBlue app
- Enables condition-based maintenance

# Electrolyzers

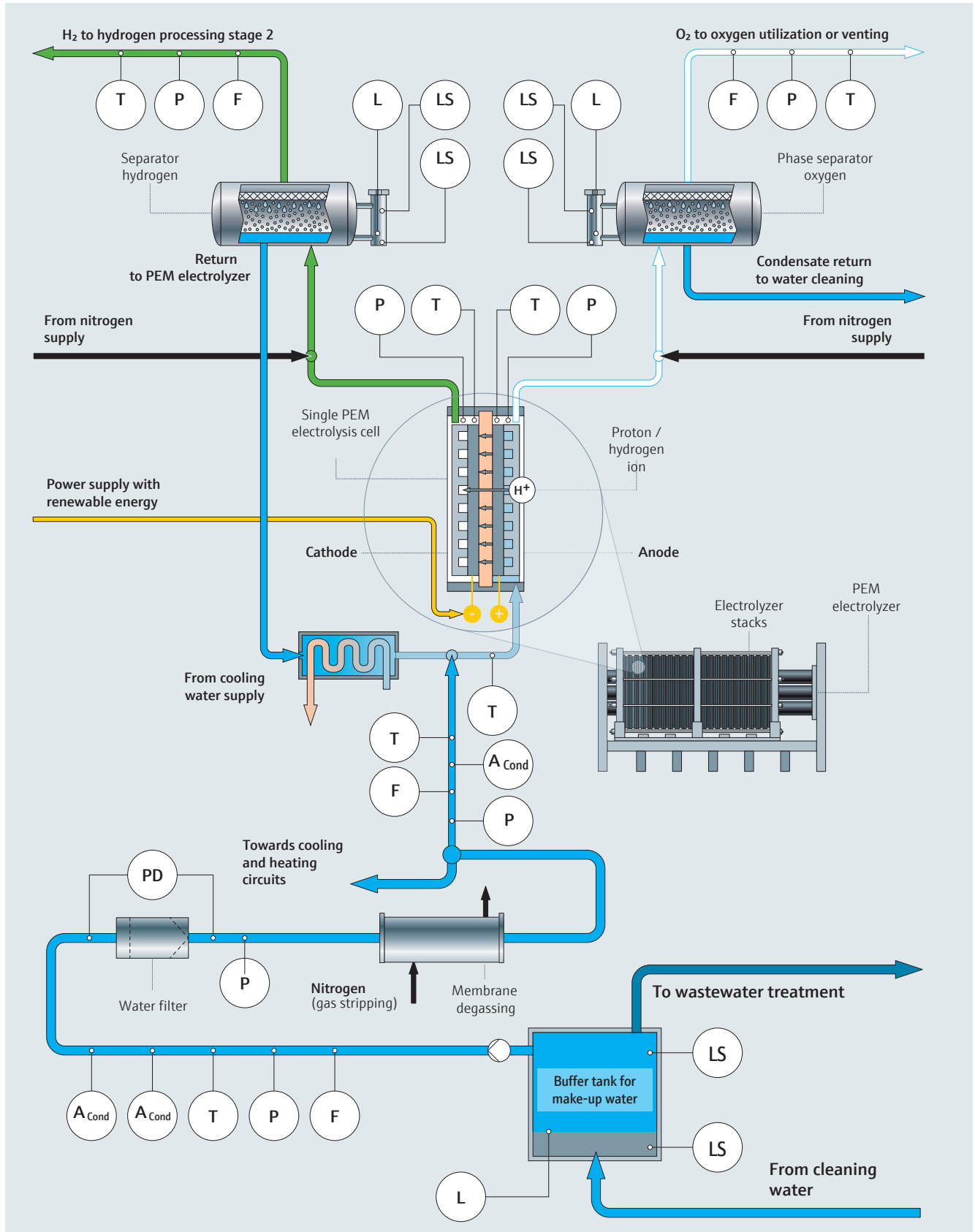
## The alkaline electrolyzer

For the production of green hydrogen, the alkaline electrolyzer is currently the most widely used technology. To optimize and ensure better production efficiency, the

following parameters need to be measured: flow, level, temperature and pressure. All these parameters are available from Endress+Hauser.



# The PEM electrolyzer



# Instrumentation for electrolyzers



## Guided wave radar level measurement – Levelflex FMP51

Technology suitable for liquid level control in hydrogen and oxygen separators, highly resistant to corrosive substances.

- Reliable measurement even in narrow measuring ranges
- Optional supply of the measuring chamber (bypass)
- Certified according to IEC 61508 for maximum safety – SIL2/3 applications
- Degreasing possible for oxygen applications



## Relative pressure transmitter – Cerabar PMP71B

Pressure measurement on all fluids present such as ultra-pure water, brine, hydrogen, oxygen and nitrogen.

- Measurement accuracy up to +/- 0.025 %
- Gold-coated membrane for hydrogen and degreased for oxygen
- Remote configuration via Bluetooth and SmartBlue app
- Verification of proper functioning through embedded Heartbeat Technology



## Coriolis mass flow measurement – Promass F 300 / A 300

Mass flowmeter renowned for its robustness, reliability and precision in measuring liquids and gases.

- High precision
- Multivariable execution integrating mass flow, temperature and even density for liquids
- No required straight inlet and outlet lengths
- Embedded Heartbeat Technology for operational performance monitoring



## Conductivity measurement – CLS16E with CM44x for multi-channel transmitter

Robust conductivity measurement assembly consisting of a conductive sensor, cable and a field transmitter suitable for demanding environments.

- Measurement range from 0.04  $\mu\text{S}/\text{cm}$  to 500  $\mu\text{S}/\text{cm}$
- Reliable and accurate measurement for low conductivity fluids
- Easy cleaning due to its stainless-steel body and removable electrode





### Liquid level detection with vibrating tuning fork – Liquiphant FTL51B

Secure your processes with Liquiphant which has more than 3,000,000 applications worldwide. Benefit from the expertise of a sensor developed and patented by Endress+Hauser.

- Certified to IEC 61508 for maximum safety – SIL2/3 applications
- Advanced diagnostics and self-testing functions with Heartbeat Technology
- Simplified loop control, even remotely via Bluetooth



### Temperature Sensor – iTHERM Moduline TM131

Pt100 sensor with an integrated thermowell, suitable for both hazardous and non-hazardous zones.

- Pt100 sensor range -328 °F to +1112 °F (-200 °C to +600 °C)
- Vibration-resistant version up to 60g (iTHERM StrongSens) or fast response time of 1.5s (iTHERM QuickSens)
- Dual Seal: containment enclosure for process safety with corrosion/leak detection within the thermowell – protects against hydrogen leakage
- Transmitter TMT82, HART with options SIL certification, dual channel inputs for delta-T or redundancy



### Vortex flow measurement – Prowirl D/F 200

Robust and dri -free capacitive sensor for flow measurement of all types of fluids: liquids (ultra-pure water, oxygen...).

- 2-wire technology for simple and cost-effective integration
- Process safety and monitoring with Heartbeat Technology
- Flanged or sandwich-mounted version available

## Hydrogen quality at electrolyzer outlet

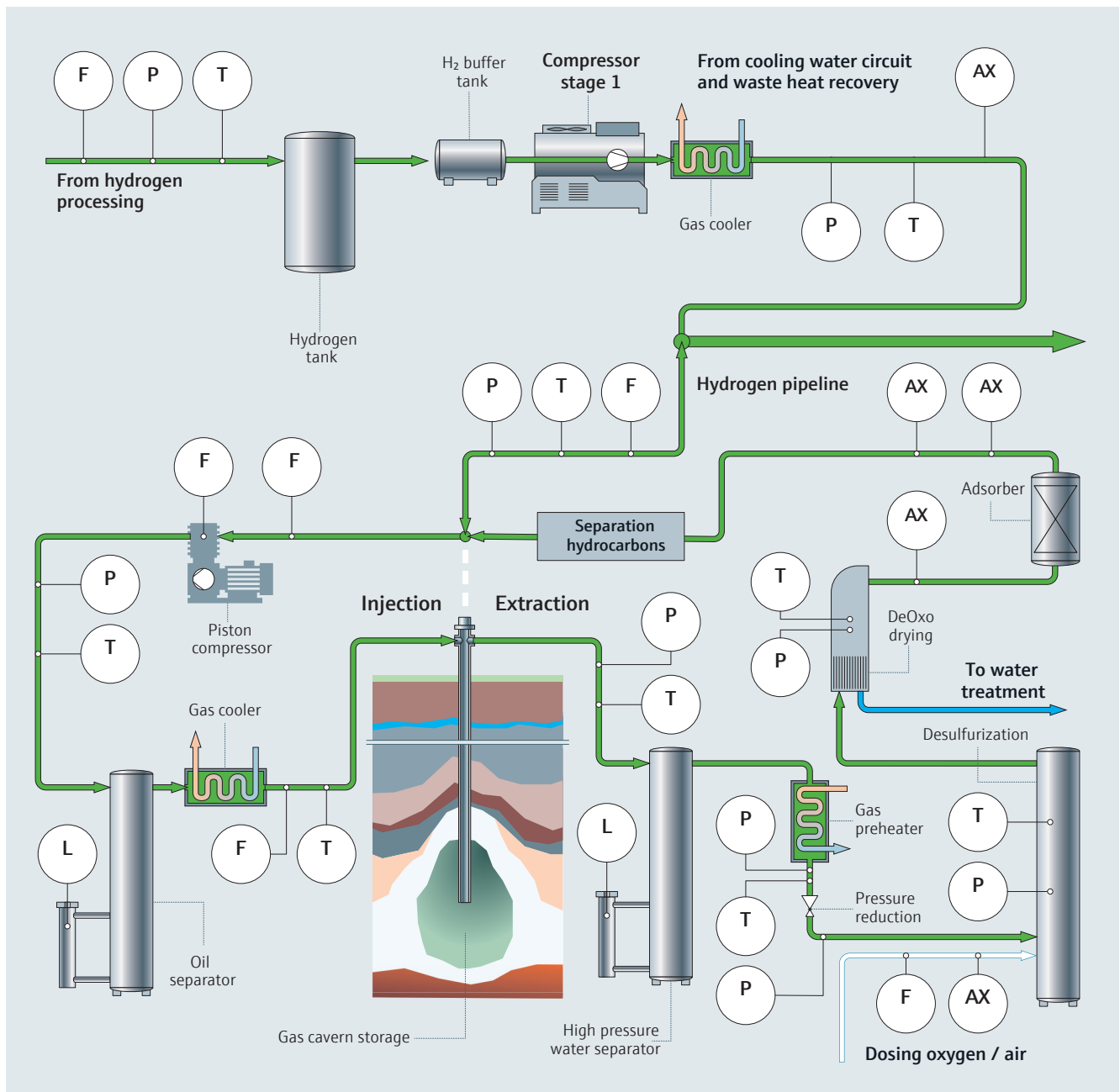
Combined Optical Analysis panel using TDLAS (J22) and Quenched Fluorescence (Oxy5500) for continuous monitoring of moisture (H<sub>2</sub>O) and oxygen (O<sub>2</sub>) in hydrogen, offering the following advantages:

- **Real-time measurement of process risk H<sub>2</sub> impurities** as outlined in ISO 19880-8 table B.5
- **Low maintenance:** No moving parts, no consumables
- **Robust and reliable construction**
- **Operational control** through embedded Heartbeat Technology on the J22 for reliable and lasting monitoring
- **Easy installation** with combined sample conditioning system mounted in single solution



# Hydrogen compression and storage

Whether it's compression or storage in caverns, hydrogen remains the unique energy vector capable of storing surplus energy. The highly precise sensors from Endress+Hauser will allow you to monitor the smooth progress of your process.





### Relative pressure transmitter – Cerabar PMP71B / PMC71B

Pressure sensor with gold-coated metallic membrane for measurements on hydrogen.

- Measurement accuracy up to +/- 0.025 %
- Measuring range up to 700 Bar
- Remote configuration via Bluetooth and SmartBlue app
- Verification of proper functioning through Heartbeat Technology

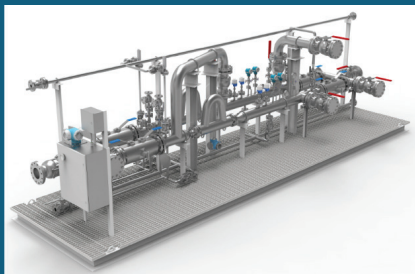


### Temperature probe – iTHERM Moduline TM131

Pt100 sensor with an integrated thermowell, suitable for both hazardous and non-hazardous areas.

- Pt100 sensor range from -328 °F to +1112 °F (-200 °C to +600 °C)
- Vibration-resistant version up to 60 g (iTHERM StrongSens) or with fast response time of 1.5 s (iTHERM QuickSens)
- Dual Seal: Containment enclosure for process safety with corrosion/leak detection within the thermowell
- Transmitter TMT82, HART with optional SIL certification

## Transfer and zero loss solutions in hydrogen



Endress+Hauser, a ONE-STOP supplier for your metering skids across the entire hydrogen value chain, including hydrogen blending into natural gas. To

ensure reliable transactions and compliance with local and international standards, our expertise in the field accompanies you throughout the project.

# Process safety

In hydrogen production applications, safety is a crucial element. Whether it involves personnel, facilities or the environment, it adheres to strict regulations and standards that evolve over time, requiring investments. However, we strive to ensure that safety does not compromise productivity for your plants.

## **i** Functional safety

- **IEC 61508 – Functional safety of electrical/electronic/programmable electronic safety-related systems:** This generic standard provides specifications for the design of safety-related systems.
- **IEC 61511– Functional safety - Safety Instrumented Systems for the process industry sector:** This international standard for process industries establishes best practices in engineering systems to ensure the safety of an industrial process through instruments. These systems are referred to as Safety Instrumented Systems (SIS).



## **i** Explosion protection

- **EX, FM and IECEx:** In electrical engineering, a hazardous area is defined as a location where concentrations of flammable gases, vapors or dust may occur. Electrical equipment intended for installation in these areas is specially designed and tested to ensure that it cannot trigger an explosion due to contact with an electrical arc or a high surface temperature of the equipment.
- Endress+Hauser instrumentation is offered across a wide variety of protection concepts including intrinsically safe, explosion proof, non-incendive and more.



## Innovations in the service of safety

### Dual Seal for TM131

High-performance temperature sensor technology (e.g. RTD or thermocouple) combined with innovative safety features guarantee the highest plant safety and availability. The integrated pressure switch allows for process leak detection, which can be communicated to the control system to alert personnel.



### Failsafe FTL80

Thanks to its self-diagnostic functions allowing it to achieve a SFF (Safe Failure Fraction) > 99% as well as its innovative system of internal redundancy, it is possible to implement it in a SIL 3 loop single track. Its 12-year test interval allows you to optimize your maintenance operations safely.

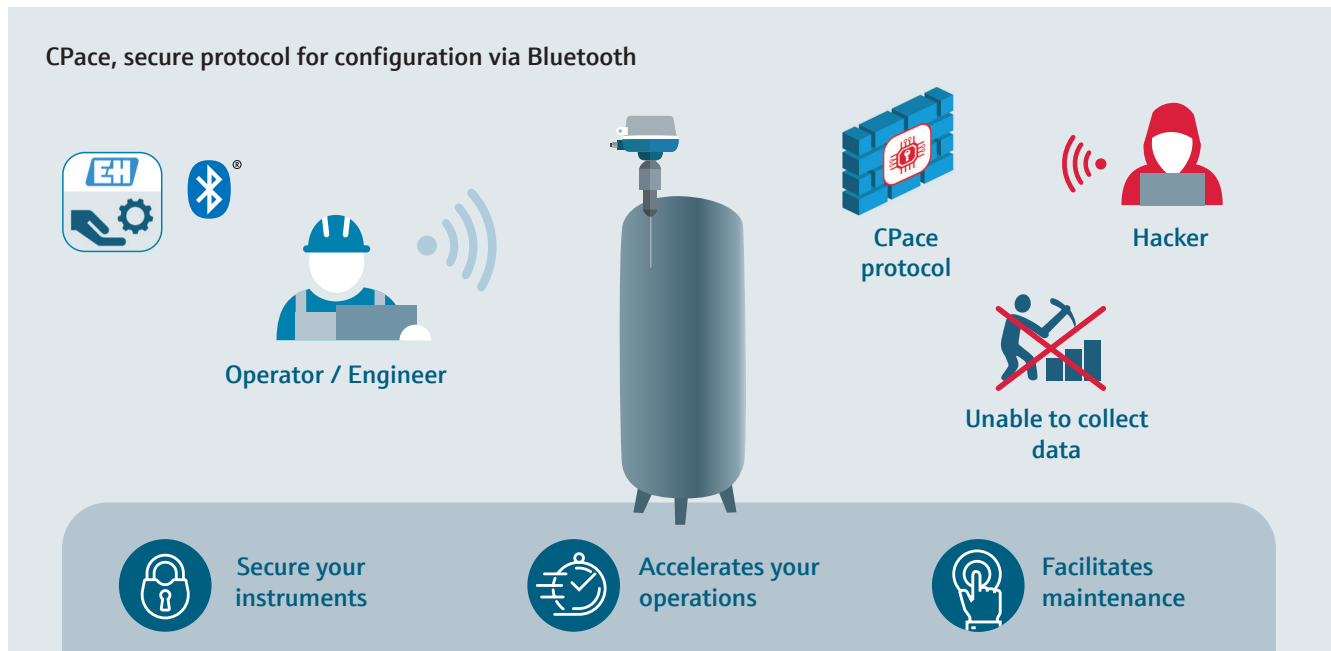


## The challenge of cybersecurity

With the advent of digitization and the presence of so-called 'connected' instruments on industrial sites, the threat of a cyber-attack is a very real risk that should not be underestimated. At Endress+Hauser, we take this risk very seriously, which is why we are certified in both the design of our connected products (IEC62443), the security of our Netilion cloud solution (ISO 27017) and the data management of our production centers (ISO 27001).

Furthermore, we have aimed to position ourselves as a global player in cybersecurity with the development of a unique encryption protocol for password-free wireless communications. This protocol, already approved by the German Fraunhofer Institute, was selected following an international competition by the EITF as the basis for future standards and is already used by all our Bluetooth devices\* to ensure optimal security!

\*Bluetooth option is enabled by chip and can be physically removed by the device or left off of the bill of materials for all associated transmitters.



## Our experts are here for you

Have a question or uncertainty about a standard? Trust our expertise:

- Qualified and certified personnel (SIL, DESP, FM, IECex, ATEX, CRN, INMETRO, NAMUR)
- Utilization of databases and useful software



Use ExiCalculator for your calculations of intrinsically safe loop Ex "I".

Download the application from the Apple Store or Play Store.



Applicator, for the selection of your devices, stress calculations, sizing and corrosion resistance.

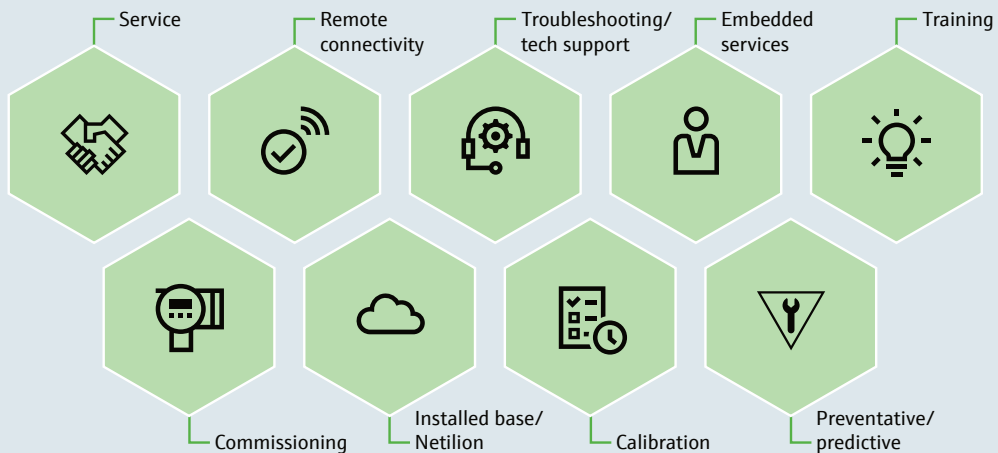


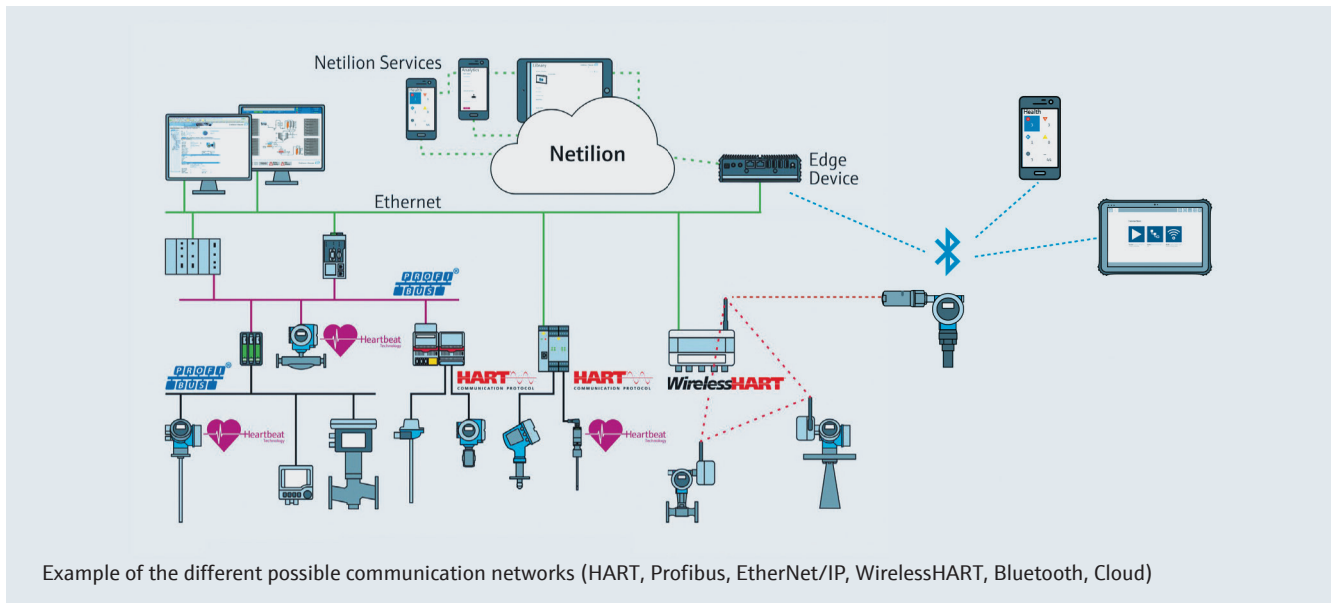
## Digitalization is at the heart of the energy transition

Today, sensors have multiple pieces of information that are not fully utilized. Digitalization allows for optimizing the monitoring and maintenance of your process.

Regardless of the chosen communication networks, Endress+Hauser is here to support you at all levels: sensors, converters and gateways.

### Predictive and preventative maintenance through verification, monitoring and diagnostics





Store



Connect



Convert



Adapt



Collect

# Optimize your maintenance, improve your process

Do you want to increase the availability of your facility and reduce your costs?

With **Heartbeat Technology**, Endress+Hauser offers the widest range of devices with an innovative diagnostic and verification concept.



Heartbeat Technology enables cost-effective and safe operation of the installation throughout its lifecycle via its comprehensive diagnostic, verification and monitoring functions.

Digital reporting with Heartbeat Verification can reduce paper use in plant shutdowns or maintenance checks while offering a pathway for partial proof testing to provide confidence that safety loops are working properly.

More straightforward and efficient control of your measuring points.

**Increase your plant performance and ...**

... boost reliability as well as safety levels

... reduce your verification efforts


... improve your process insights

**Heartbeat Technology**


for diagnostics

for verification

for monitoring



Permanent process and device diagnostics



Documented device functionality without process interruption



Information for process optimization and predictive maintenance

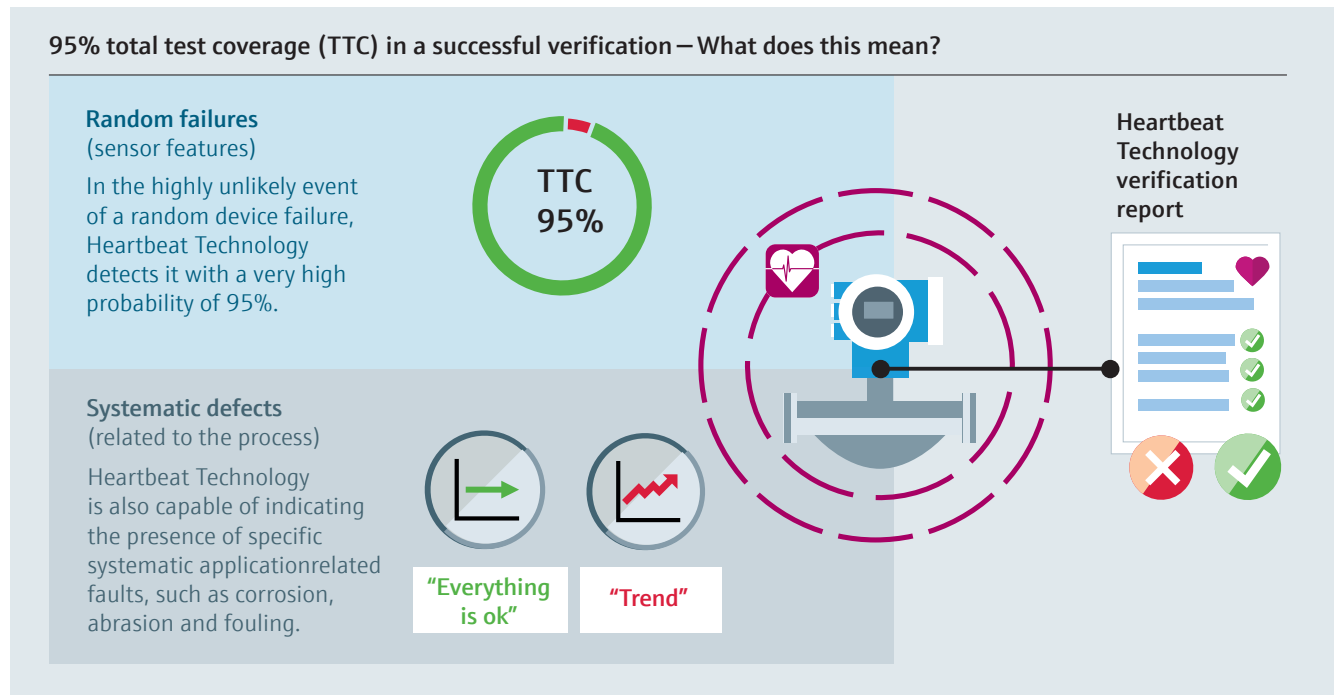
- Explicit and standardized **diagnostic messages** with clear operation instructions facilitate maintenance
- **Permanent self-diagnostics** of the device enables safe operation with extended verification cycles
- The automatically generated **report of proper functioning** assists users in meeting regulatory demands
- The measuring point can be **verified in-situ and documented** at any time
- The simple and guided verification procedure yields clear verification results
- **Coriolis flowmeters:** Abrasion detection – corrosion or tube fouling detection – entrained gas detection
- **Vibrating fork level detection:** Corrosion or abrasion detection of the forks
- **Pressure/differential pressure:** Detection of blocked impulse lines, water hammer, corrosion in the current loop



## Heartbeat Verification: Improve production and maintenance efficiency in a comfortable, safe and compliant manner

With **Heartbeat Verification**, the functionality of your measuring device can be assessed at any time, in-situ, and in a very short time, without the need for external tools or interrupting the process. Verification not only involves checking whether the components of the device still

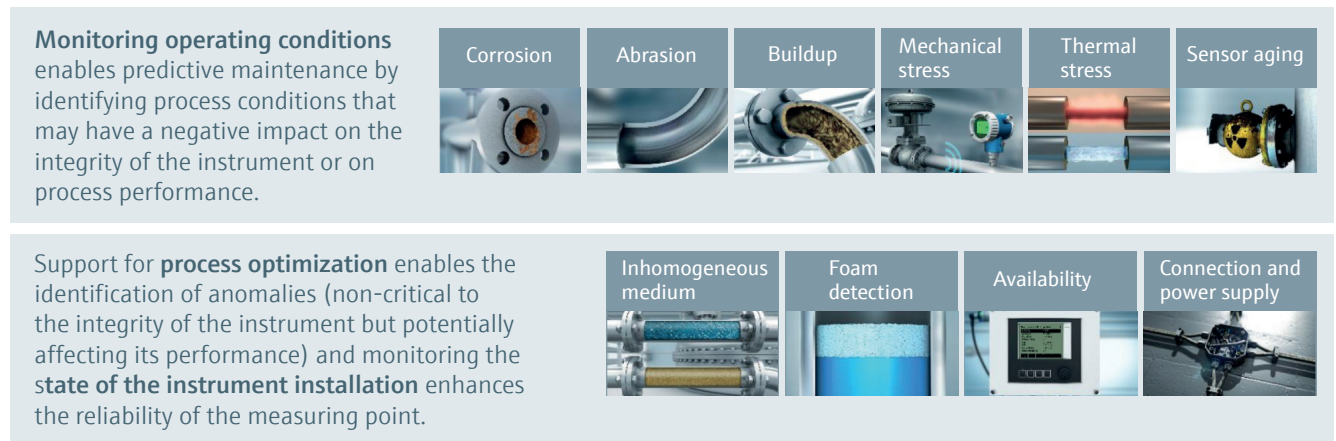
conform to their original reference values but also indicates the presence of systematic faults that could have a negative impact on the device or process performance, such as corrosion, abrasion or fouling.



## Heartbeat Monitoring: Be efficient and proactive in your operations

In **particularly challenging process conditions**, certain events can occur and influence the performance and reliability of a device. Examples of such events include corrosion or abrasion of parts of the sensor in contact with the fluid or the appearance of foam in a tank. These

events will influence the physical responses of the device. Heartbeat Technology detects these events and converts them into easily understandable information by providing insights into the process and the device.



# Compliance of measuring points

The performance and compliance of your installations and measuring points require a rigorous and systematic approach to monitoring the critical instrumentation fleet. Call on us during your shutdowns or other maintenance activities.

## Commissioning: your guarantee for operational instruments

Benefit from Endress+Hauser's expertise to commission instruments optimally. Take advantage of the extended warranty to cover any unforeseen costs and reduce the total cost of ownership.

## Support and maintenance contract

With the service contract, you optimize your instrument fleet without the risk of additional costs. The implementation of a contract provides you with additional peace of mind.

- Be sure that maintenance services are carried out on time
- Receive regular visits from a technician who provides maintenance advice
- If you wish, spare parts can be included in the contract
- Contracts can also include equipment from third-party manufacturers

## Accredited laboratory calibration

Temperature, pressure, flow, physico-chemical analyses (conductivity, pH).

- A single provider for all types and brands of equipment
- Services performed according to metrology standards and references (NF EN ISO/IEC 17025, NF EN ISO 10012, NIST, ASME MFC-9M)
- Accredited laboratories AL2A, COFRAC, SCS, SIT or Dakks (DKD)



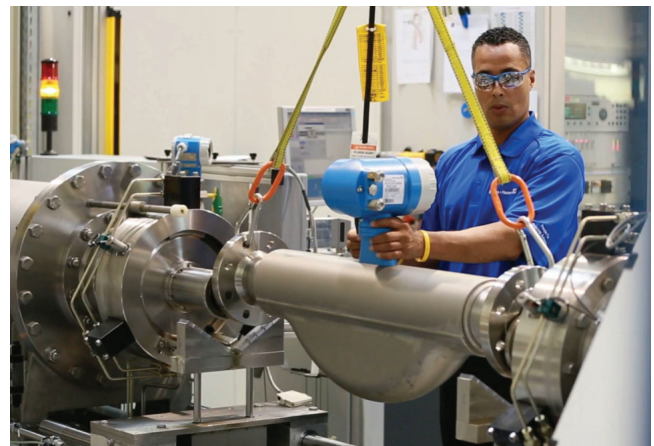
## On-site calibration of your flowmeters with our Mobile Labs

For reasons of finished product quality and regulatory compliance, it is necessary to periodically check the measuring performance of critical instruments. Flow is one of the most important parameters in the process but also the most difficult to control.

To address this issue, we offer on-site calibration of flowmeters in a minimum of time and constraints. This service is performed with our new fully autonomous mobile calibration rig equipped with a water reservoir. With minimal footprint, this rig is designed to be brought as

close as possible to the process. The device is placed on the rig, calibrated and immediately reinstalled on the process.

- The most accurate service on the market
- Endress+Hauser instrumentation and third-party manufacturers
- Time savings and simplified planning
- Cost effective



### Our offer We are able to field calibrate flowmeters of all brands

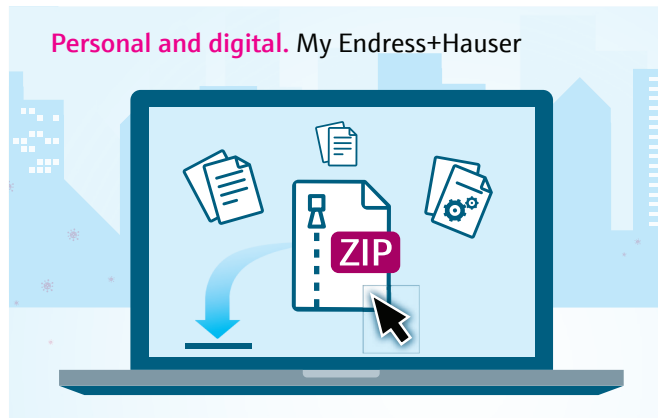
<b>Type of instruments</b>	From DN10 (3/8") to DN80 (3") – other diameters on request <ul style="list-style-type: none"> <li>■ Electromagnetic flowmeters</li> <li>■ Coriolis mass flowmeters</li> <li>■ Vortex flowmeters</li> <li>■ Inline ultrasonic</li> <li>■ Third-party rotameters</li> </ul>
<b>Fittings</b>	ASME or DIN flanges, ISO 2853 Clamp, Tri-Clamp, SMS 1145 and DIN11851 fittings
<b>Calibration range</b>	0 to 100 gal/min
<b>Uncertainty calibration (k=2)</b>	± 0,25 % or the value read*
<b>Calibration fluid</b>	Water
<b>Number of points</b>	2 points as standard in the calibration range, 3 <sup>rd</sup> point optional
<b>Documents provided</b>	<ul style="list-style-type: none"> <li>■ Calibration certification or Verification Report delivered on-site</li> <li>■ Proof of traceability of standards available on our website</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>■ Guaranteed maintenance service provided for Endress+Hauser electromagnetic flowmeters</li> <li>■ Adjustment of flowmeters as feasible</li> </ul>

\* The uncertainties are not guaranteed and may be reduced by the device being calibrated (stability, repeatability...)

# My Endress+Hauser always at your fingertips

Keep an overview of your prices, transactions and more with My Endress+Hauser.

The new features transform endress.com into a powerful and intelligent cooperation platform that connects you directly to us and our extensive network of sales representatives. Your personalized space allows you to perform your operations in just a few minutes. Manage your transactions, purchase products, order spare parts, download documentation and access your contacts – at the office, in the field or on the go, all with **My Endress+Hauser**.



[www.addresses.endress.com](http://www.addresses.endress.com)

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