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Ingenuity for life

Digitalization in Process Industries enables the Fourth Industrial (R)Evolution

Advantages of gas analysis
HF measurement on Aluminium with Laser LDS6

Agenda

Megatrend Digitalization and Industrie 4.0

Megatrends –
Challenges that are transforming our world

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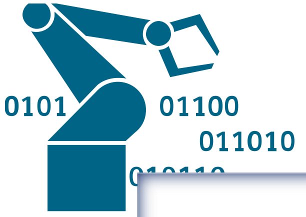


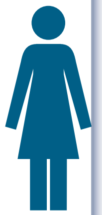
Digitalization

By 2020, the digital universe will reach **44 zettabytes** – a 10-fold increase from 2013[1]

Urbanization

By 2050, **70 percent of the world's population** will live in cities (2014: 54 percent)[3]

s industry



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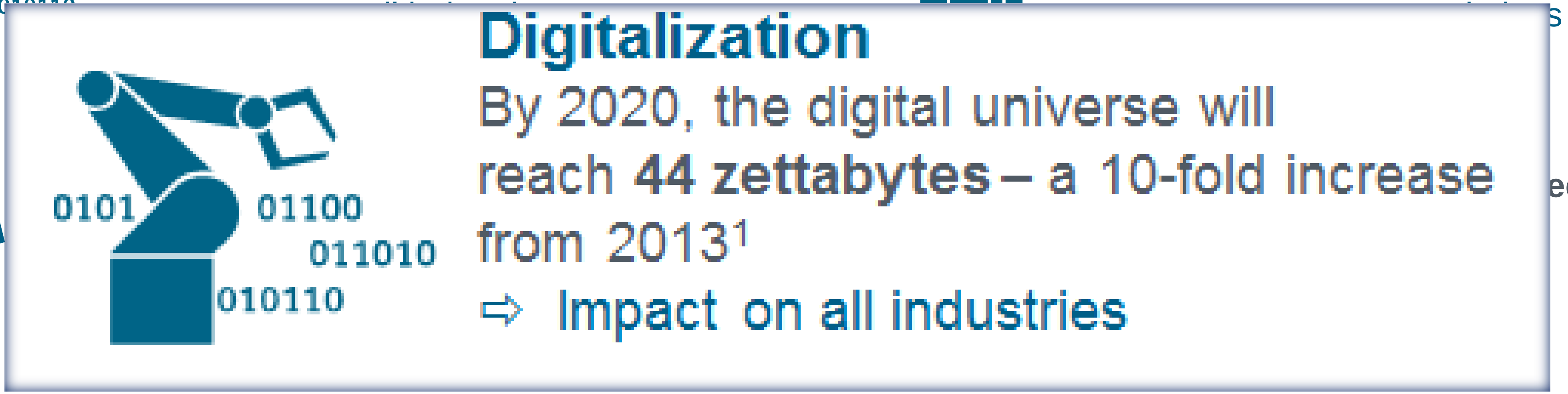


Climate change

According to scientists, in the summer of 2015, earth's atmosphere had the **highest CO_2 concentration** in 800,000 years[4]

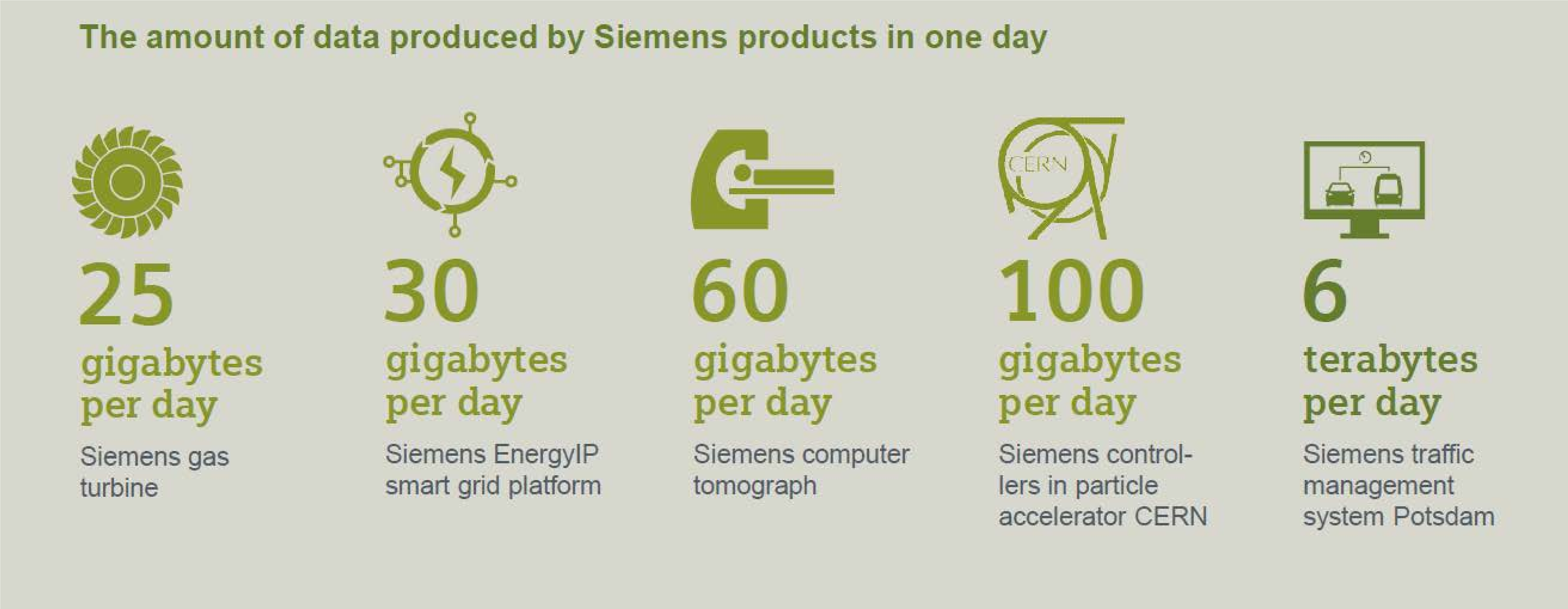
⇨ Impact on water industry

Sources:

1. IDC, The Digital Universe of Opportunities: Rich Data and the Increasing Value of the Internet of Things, April 2014
2. United Nations, Department of Economic and Social Affairs, Population Division (2015). World Population Prospects: The 2015 Revision, Key Findings and Advance Tables. Working Paper No. ESA/P/WP.241
3. United Nations, World Urbanization Prospects. The 2014 Revision, New York, published 2015
4. SCRIPPS INSTITUTE OF OCEANOGRAPHY, The Keeling Curve, November 11, 2015
5. UNCTAD Statistics, Values and shares of merchandise exports and imports from 1948 to 2014, November 10, 2015

Increasing amount of data is generated by megatrend Digitalization

Siemens installed base and data generated



From Industrie 1.0 to Industrie 4.0, initiative sponsored by the German Government shows importance of a local approach

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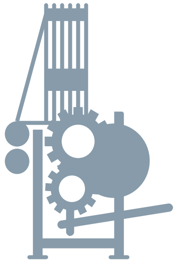
First
Industrial Revolution

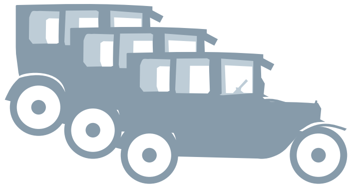
Based on the introduction of mechanical production equipment driven **by water and steam** power



1784: First mechanical loom

Second
Industrial Revolution

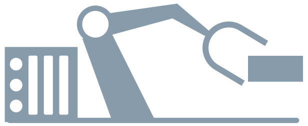
Based on mass production achieved by division of labor concept and the use of electrical energy (**electrification**)



1870: First conveyor belt, Cincinnati slaughterhouse,
1908: Ford T-Model

Third
Industrial Revolution

Based on the use of electronics and IT to further automate production (**automation**)

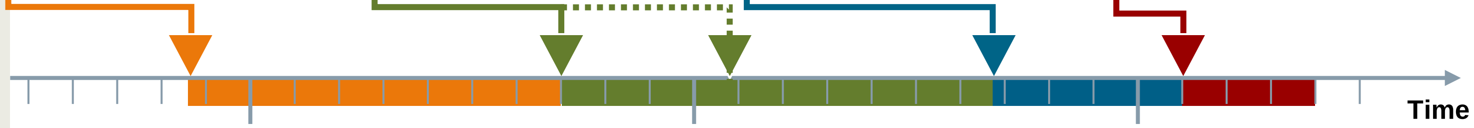


1969: First programmable logic controller (PLC) Modicon 084,

Fourth
Industrial (R)Evolution

… driven by **Digitalization**, Integration and enhanced Flexibility

Plattform INDUSTRIE 4.0

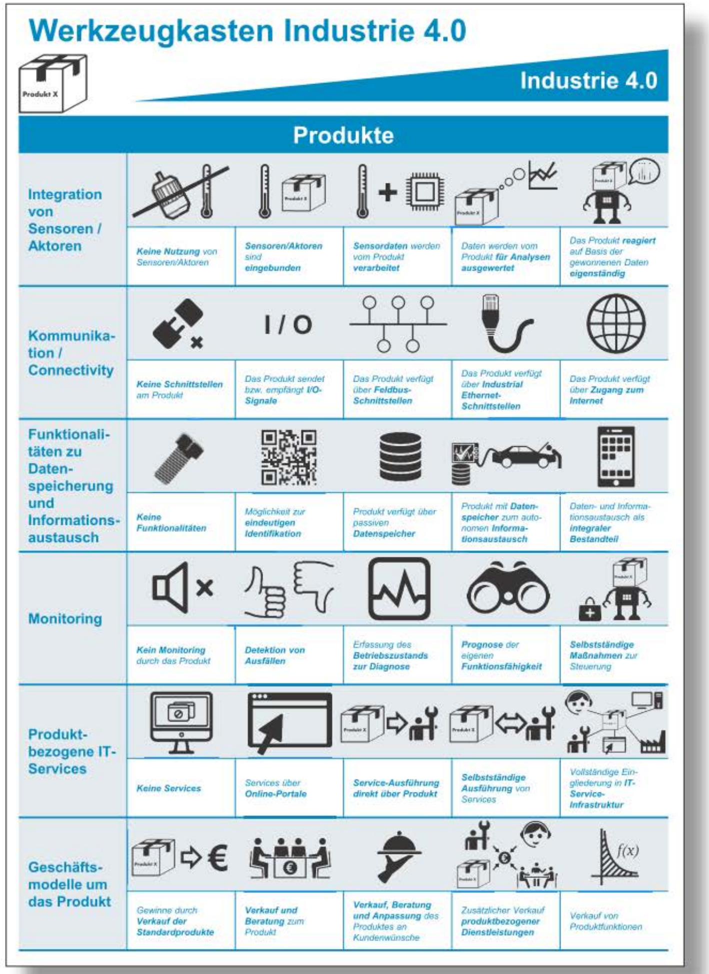


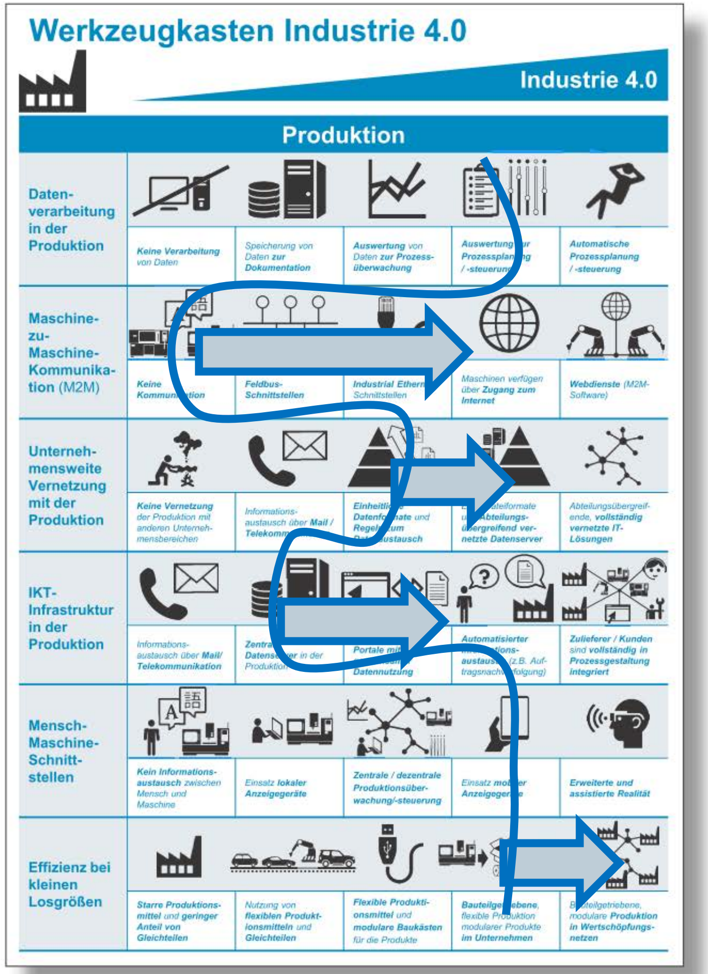
Characteristics

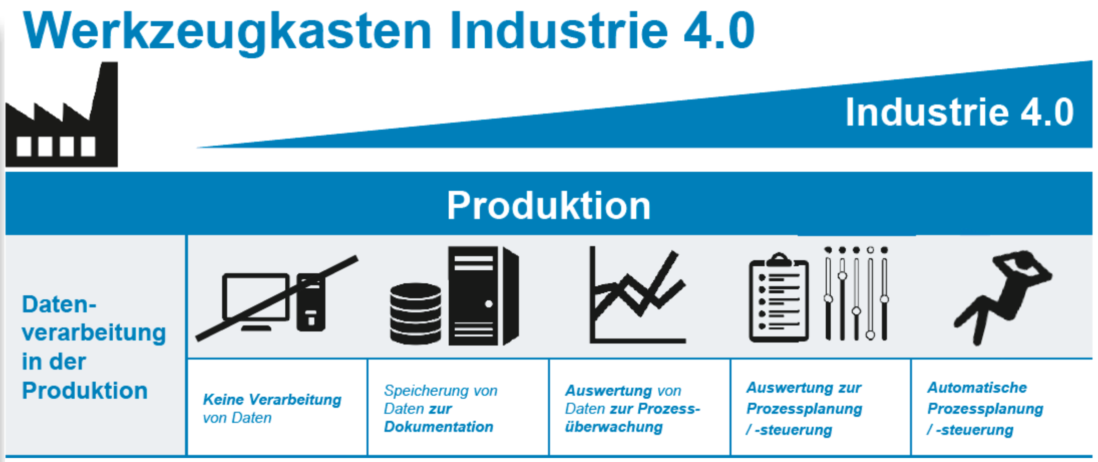
- Humans, devices and systems are connected along the entire value chain
- All relevant information is available in real-time – across suppliers, manufacturers and customers
- Parts of the value chain can constantly be optimized with respect to different criteria, e.g. cost, resources, customer needs

Exemplary research initiatives: Industrie 4.0 (I4.0) sponsored by the German Government, Industrial Internet Consortium (IIC), Made in China 2025, Internet of Things (IoT)

VDMA 2015: orientation guide for implementation within small and medium-sized businesses







Communication
- Profinet, …

Data collection and administration
- Instrumentierung, Int. Eng., …

Integrated Engineering
- COMOS & PCS 7, …

Quelle: VDMA Leitfaden Industrie 4.0, 2015 (978-3-8163-0677-1)

Industrie 4.0 analysis & studies
PWC 2014: Whitepaper – key findings of survey

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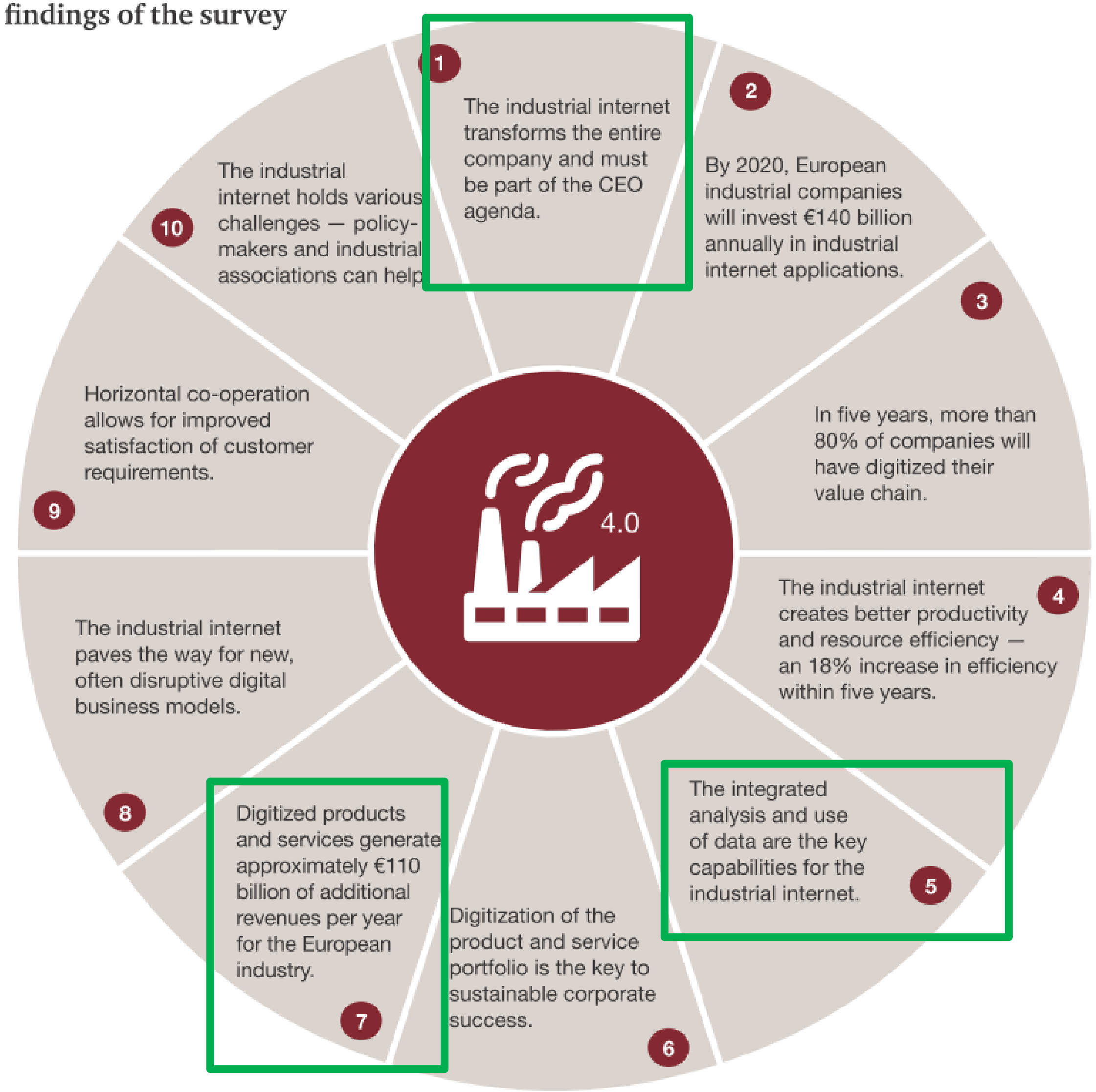
Key findings of the survey



"… the share of investments in Industry 4.0 solutions will account for more than 50% of planned capital investments for the next five years. German industry will thus invest a total of €40 billion in Industry 4.0 every year by 2020. Applying the same investment level to the European industrial sector, the annual investments will be as high as €140 billion per annum."

Industry 4.0 will transform our entire value chain and allows us to develop innovative products and services. We must act now!

CEO, manufacturer of processing machines

We already have many digital initiatives in our company — but no shared vision and roadmap in terms of where we want to go with Industry 4.0.

CEO, machine and plant engineer

Quelle: PWC Studie 2014
"Industry 4.0 - Opportunities and challenges of the industrial internet"

Siemens terms its approach to Digitalization in industry and its way towards Industrie 4.0 the “Digital Enterprise”

Optimization through Digitalization

In addition to the megatrends the market dynamics present challenges for Process Industries

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Time to market

- From idea to production
- Ramp-up of plant

Flexibility

- Individualized products / quantities
- Different feedstock

Efficiency

Output

- Demanded product / quantity
- Productivity

Costs

- Operational excellence
- Resources

- **Long plant lifecycles** (> 40 years) with highly **fragmented data landscape**
- **Continuous, safe and reliable** operations
- Need to address **different feedstock, markets and quantities**
- **Lack of operators** and **"digital natives"** as next generation

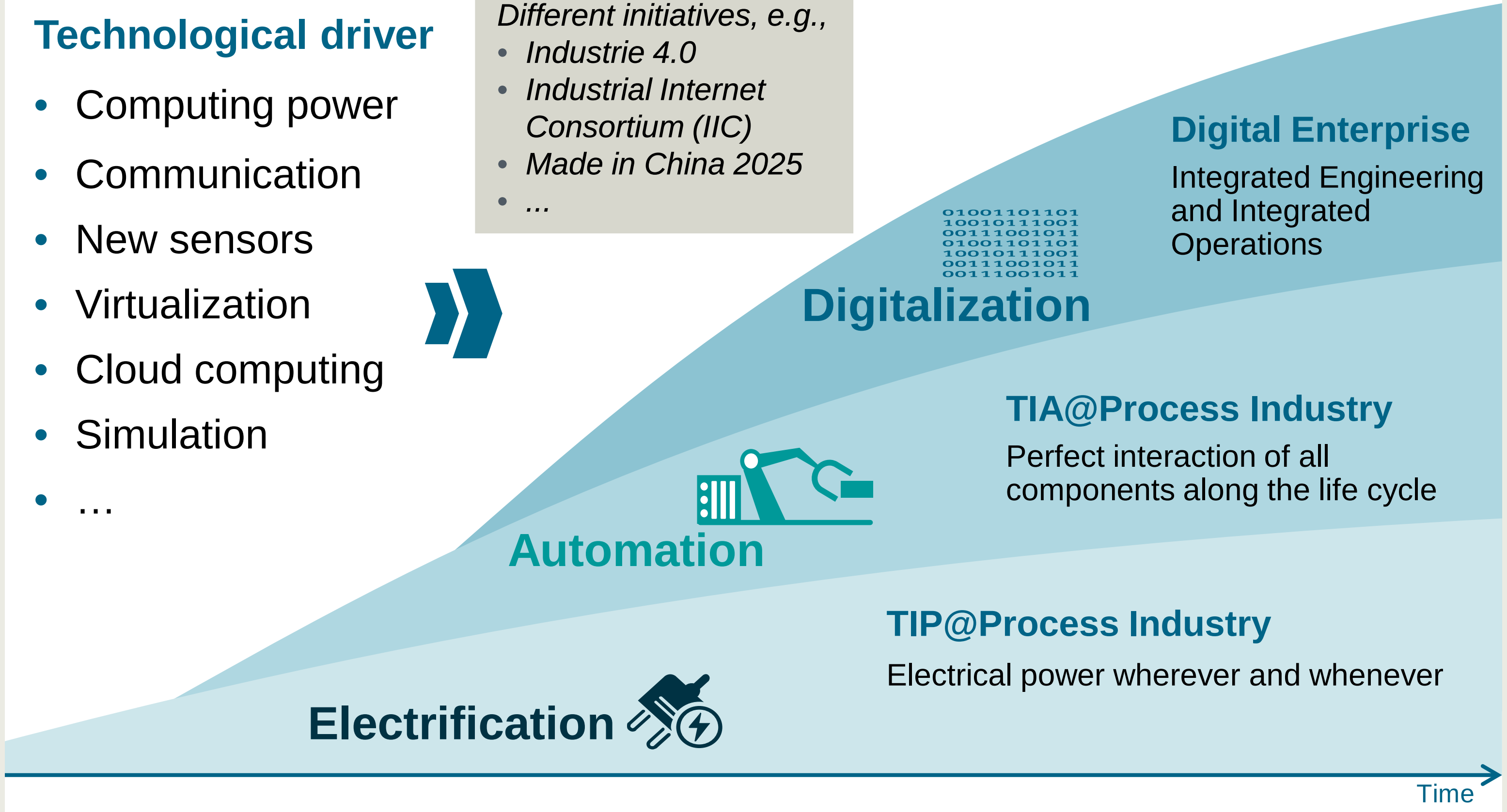
Digitalization is next level to yield productivity within Process Industries

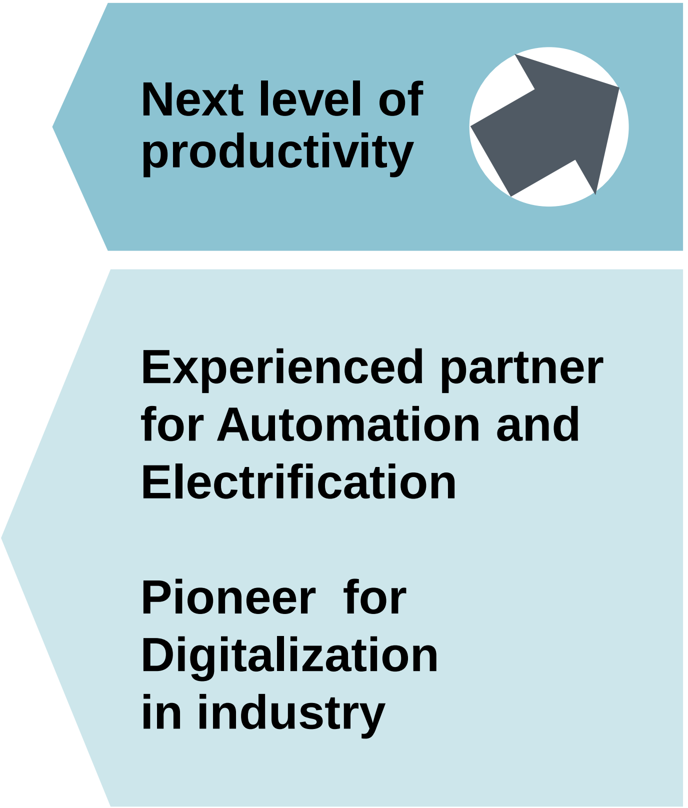
Process Industries → Electrification, Automation and Digitalization as levers to increase productivity

Technological driver

- Computing power
- Communication
- New sensors
- Virtualization
- Cloud computing
- Simulation
- …

Different initiatives, e.g.,
- *Industrie 4.0*
- *Industrial Internet Consortium (IIC)*
- *Made in China 2025*
- *...*





Our approach to Digitalization for Process Automation:
From Integrated Engineering to Integrated Operations

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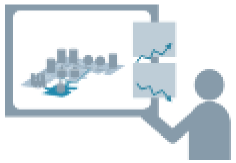
Product design | **Process & plant design** | **Engineering & commissioning** | **Operation** | **Services**

Optimization through Digitalization

Digital plant design, tools, and processes with…



Production excellence with…

Integrated Engineering

Integrated Operations

Integrating engineering information and processes on the basis of one data model with the interface/interplay of different engineering and automation systems.

Execution of operation and maintenance tasks without media breaks due to a seamless transition and the consistent data flow between engineering and plant operation.

Benefits

Lower CAPEX
Optimal OPEX

with …

- Optimum efficiency
- Increased reliability
- Higher quality
- Smarter decisions
- Greater flexibility in optimization

Siemens realizes Digital Enterprise for Process Industries through Integrated Engineering and Integrated Operations

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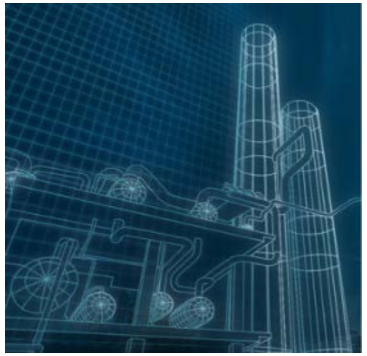
Digital Enterprise for Process Industries → Focus of Siemens



Integrated Engineering optimizes engineering and life cycle management …

- Integrated engineering tools
- Simulation
- Common data model

- Cloud-enabled services and analytics
- Next generation of Control
- Digitalization of field level
- Reliable connectivity

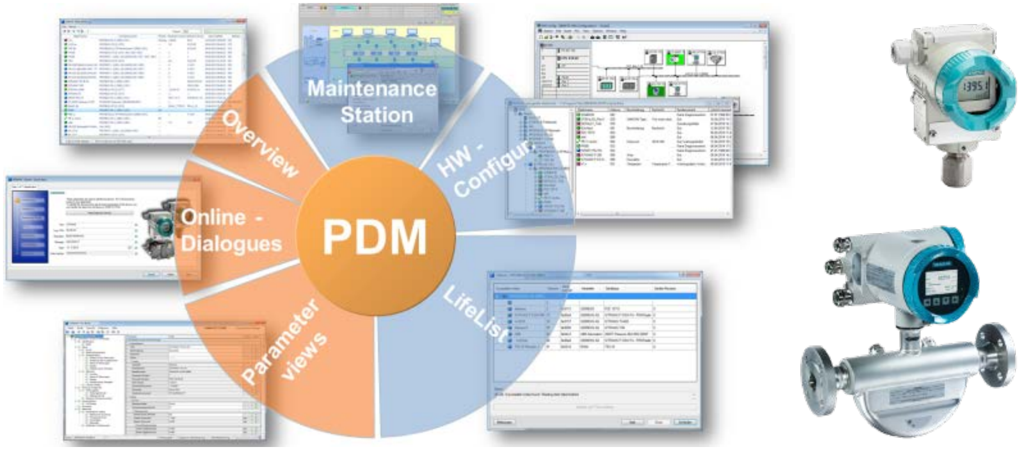
… **Integrated Operations** improves productivity and flexibility

Product design → Process & plant design → Engineering & commissioning → Operation → Service

SIMATIC PCS 7 Plant Asset Management supports perfect integration of SITRANS field devices into SIMATIC PCS 7

Integrated Engineering: *Integration of SITRANS Field Devices in PDM*

Initial situation



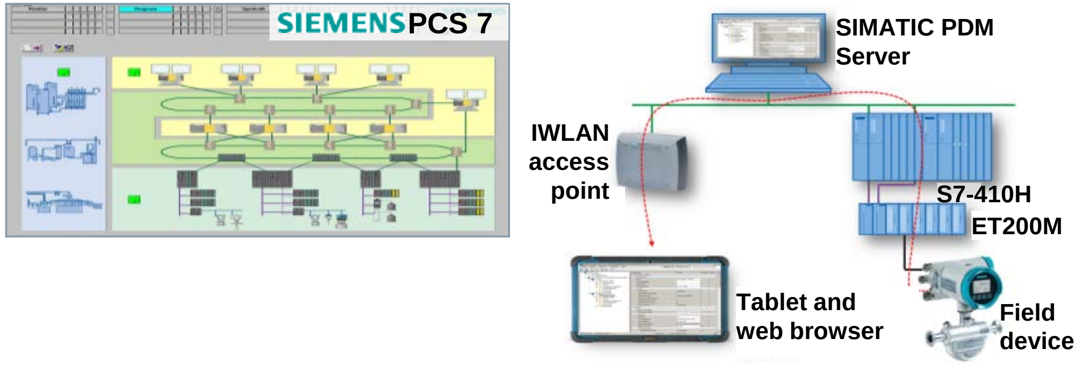
Challenges

- **One tool** for
  - Parameterization
  - Diagnostics
  - Commissioning
  - Maintenance
  - Service

Value Proposition

- **Fast commissioning** and overview of **plant wide diagnosis**
- Secure access via **fieldbus network** (e.g., HART, PROFIBUS, Fieldbus)
- **Mobile access** via client server solution

Actual status



Outstanding device integration

- **Easy and fast commissioning** via quick start wizards
- Hierarchical structure with plant wide **overview of device status**
- Structured **access to all device functions** and **parameter**
- **Life cycle management**, e.g., tracking of changes, documentation
- **Mobile service** through support of tablets via Industrial WLAN

Process information and improved integration of field level are basis for transparency and optimization

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Integrated Operations with Siemens → Digitalization of field level

Today

Gather information

LDS 6

SITRANS FC430

- **Advanced sensors**, e.g., multi variable sensors, quality and asset condition information, increased accuracy
- **Customized and application driven sensors**
- Advanced, easy to use, accurate **extractive analyzers** as well as **in-situ analyzers**, i.e., TDLAS [1] based

Evaluate information

Analyzer System Manager

- **Use of gathered information** (partially <1% used [2]), e.g., with ASM, XHQ
  - Transparency with **KPIs** and **dashboards**
  - **Maintenance, reliability, accuracy**
  - Optimized processes with **analytics**

Simple integration

SITRANS FC410 3D-Rendering

- **Product libraries** integrated in COMOS and PCS 7, **2D/ 3D** and **simulation models**
- Easy **integration in automation**
- **Connectivity** other devices

Our vision

- Grid of (basic) sensors, smart sensors and virtual / soft sensors (**big data** approach)
- **Control in the field** and **modular plants**
- **Distributed high performance** transmitter style **analyzers** in all rough environments

- **Transparency** on process and field conditions
- Advanced **analytics, real-time** process optimization
- **Smart grids** (field, control) **automatically react** on changes in process or field conditions

- **Digital twin of sensors**
- Seamless integration: **“Plug’n’produce”**
- Sensor grids with **IP-based communication, devices as I/O node**

1) TDLS = Tunable Diode Laser Absorption Spectroscopy 2) Mc Kinsey Global Institute Analysis, 2015

HF measurement on Aluminium plants with TDLAS

Aluminium production and emissions of hydrogen fluoride

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Where the HF is coming from?

Industrial aluminium smelting is the process of extracting aluminium from its oxide, **alumina** (Al_2O_3) – generally the Hall-Héroult process is used

(Al_2O_3)

Alumina has a **very high melting point**

To reduce the required energy, alumina is dissolved in molten **cryolite** (Na_3AlF_6) in the electrolytic reduction of aluminum oxide

- **Unwanted drawback**: HF-containing emissions are released
- **Hydrogen fluoride** is a highly dangerous colorless gas, forming corrosive and penetrating hydrofluoric acid upon contact with moisture
- Most of the HF-containing process gas is re-circulated within the process, but some is carried via ducts **to filters** where the HF is adsorbed and removed

What are the challenges with HF?

- Hydrogen fluoride forms **hydrofluoric acid** upon contact with moisture (e.g. air moisture)
- This highly corrosive liquid etches most materials and **threatens machinery** and plant assets
- Hydrofluoric acid is also a **contact poison**, it penetrates tissue more rapidly than typical mineral acids
- Dermal contact with hydrofluoric acid **can cause severe skin burns**
- HF may reach dangerous levels without an obvious smell
- **Poisoning** can occur through exposure of skin or eyes, when inhaled or swallowed

➢ Typically the smelters have **emission limit values** (ELVs) for hydrogen fluoride emissions

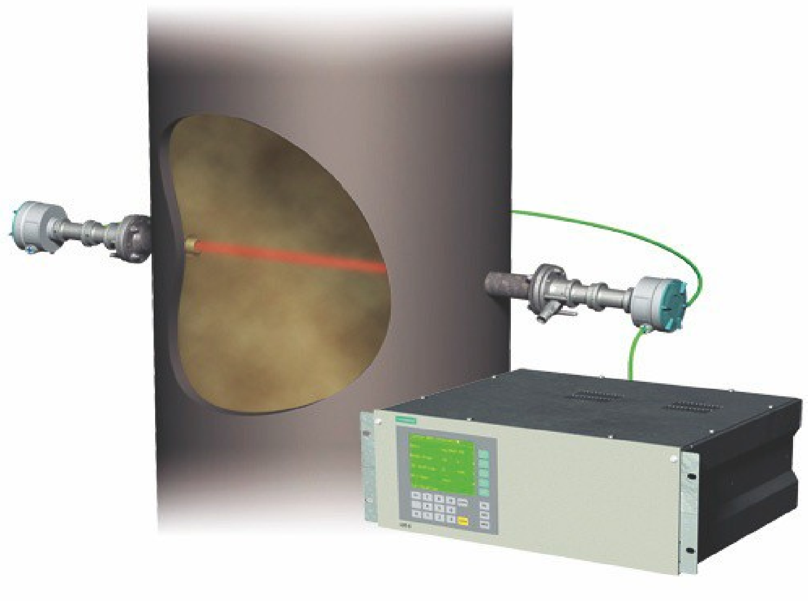
Continuous Emissions Monitoring (CEM) of HF

- In terms of **Health, Safety and Environment (HSE)**, emissions must be measured accurately and with good precision
- But furthermore, a Continuous Emissions Monitoring System can lead to **cost savings due to optimization of process activities**
- Historically, **cassette samplers** and **wet chemistry techniques** have been used for HF monitoring at the pot room roof-line and the scrubber ducts
- HF being a strong adsorber, any attempt to do this measurement using **extractive method would lead to huge errors** because the gas going to the analyzer would be different than the one entering into the probe
- So for several years, **laser gas analyzers** displace these traditional methods – for a lot of reasons …

In-situ diode laser gas analyzing

Advantages of in-situ diode laser gas analyzers

- Measurement is performed **non-intrusively** and in **real-time** – without any disturbance or delay due to gas sampling or gas conditioning
- It provides a **direct measurement of HF**
- The method is **interference-free**: The linewidth of the laser light used is about 1/10th of the width of the single HF absorption line detected
- Laser gas detectors can **measure over long ambient paths**
- **Tunable Diode Lasers** (TDLs) are small, solid-state devices that operate at room temperature and have **long-term reliability**



Siemens LDS 6 – The right choice!

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- **Siemens LDS 6** is a diode laser gas analyzer for
  O_2, NH_3, HF, H_2O, CO_2, CO, HCl
- LDS 6 is suitable for fast and non-contact measurement of gas concentrations
- One or two signals from **up to three measuring points** are processed simultaneously by the central analyzer unit
- The in-situ cross-duct sensors at each measuring point can be separated up to 700 m from the central unit by using fiber-optic cables
- The sensors are **designed for operation under harsh environmental conditions** and contain a minimum of electrical components
- LDS 6 sensors can be **operated in strong DC magnetic fields**
- Little installation effort and minimum maintenance requirements
  - High **long-term stability** through built-in, maintenance-free reference gas cell
  - **No field calibration** is necessary!

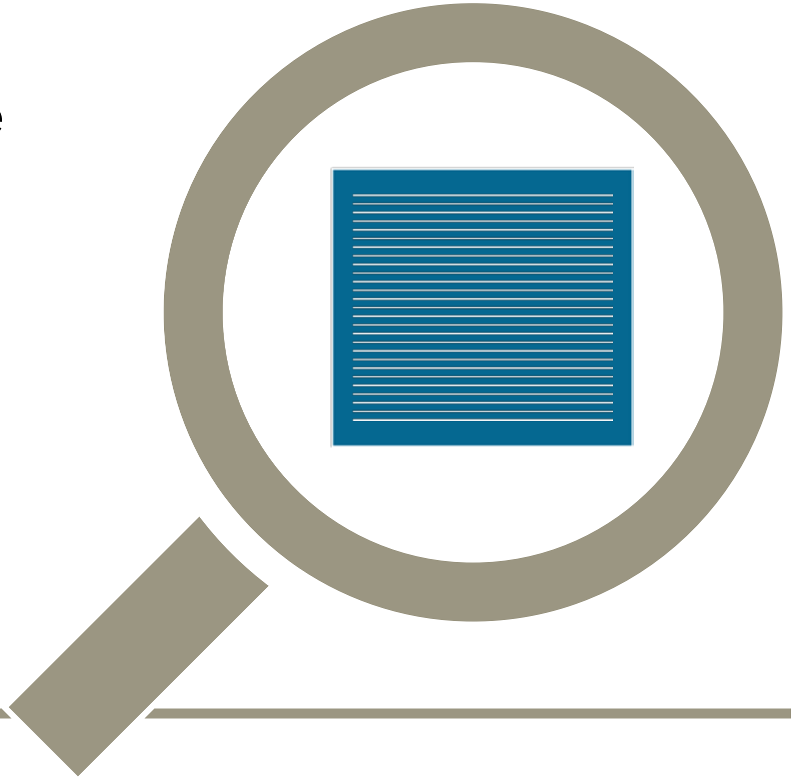
Use case 1 – Dry filters

Flue gases in aluminium production sites are cleaned in a so called **bag house filter**

- On the surface of the bags lime or sodium bicarbonate is sprayed to create a so called “cake” which is adsorbing the HF on their surface
- Since the adsorption capabilities of the cake is limited, the cake has to be renewed from time to time

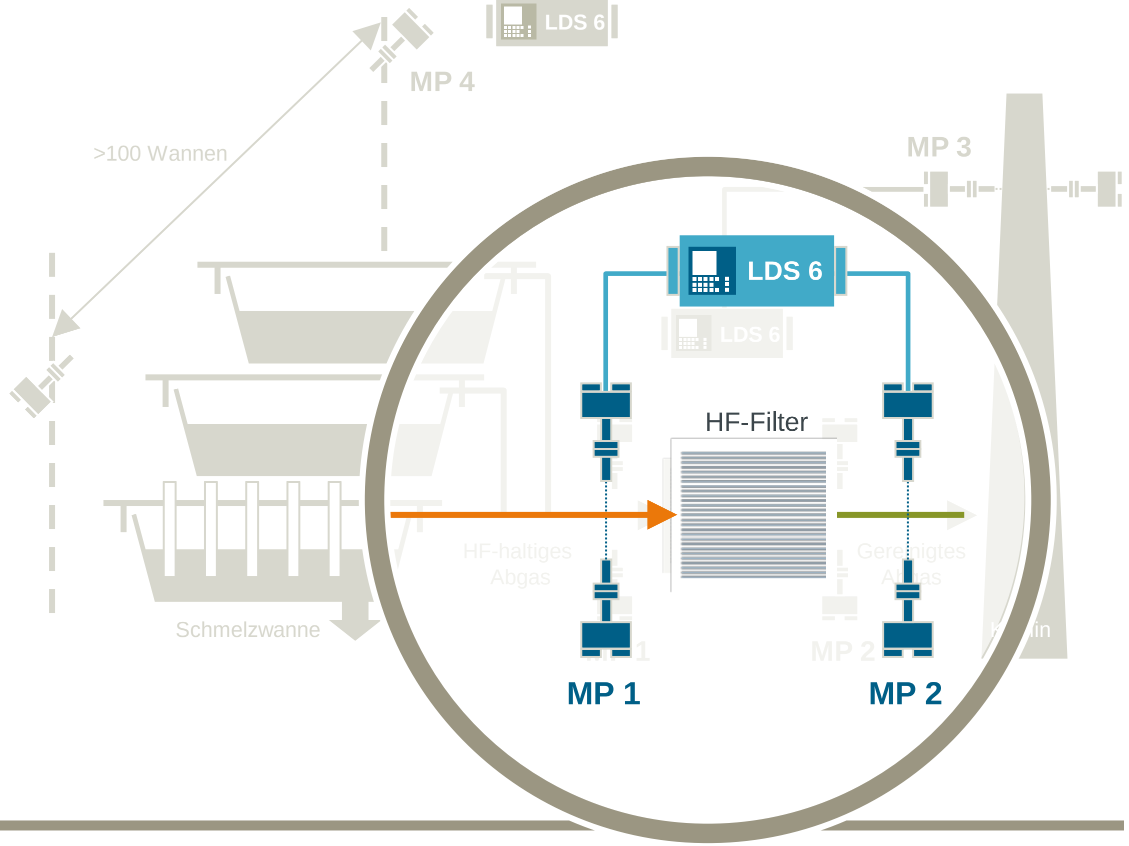
Figuring out the **best moment for the renewal** is crucial for the process optimization which is **determined by two conditions**

1. Increased emissions due to exhausted cake adsorption capabilities
2. Unnecessary cake refreshment that leads to increased usage of lime or sodium bicarbonate



Application solution for use case 1 – Dry filters

- The first channel of the LDS6 is located upstream the bag house filter and gives to the DCS the concentration of the HF entering the bag house filter
- Therefore **the DCS can anticipate**, eventually, to shake the bags and renew the cake of adsorbant powder in case of a sudden increase
- The LDS 6 is installed to measure the concentration of HF just before and after the filter (measuring spots 1 and 2)
- If a significant change in the ratio of HF in raw and filtered gas occurs, a change of filter material is indicated
- **Exchanges before time are avoided, exchange costs are reduced and filter efficiency is improved**
- Range: 0-2,000ppm, fast response time: 1s, 150C>T>250C, ambient pressure



Use case 2 – Emission monitoring at the pot room roof

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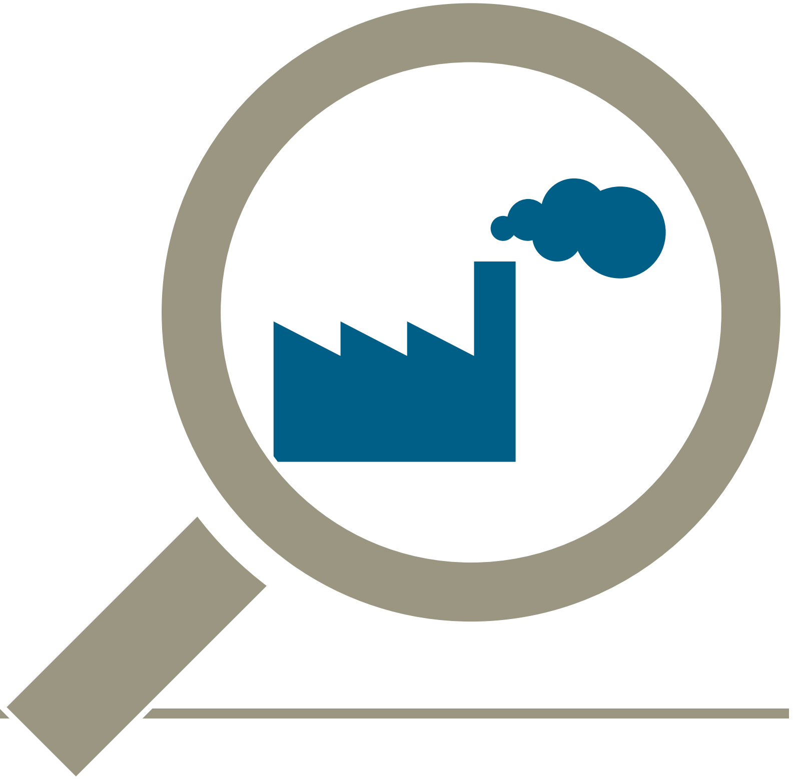
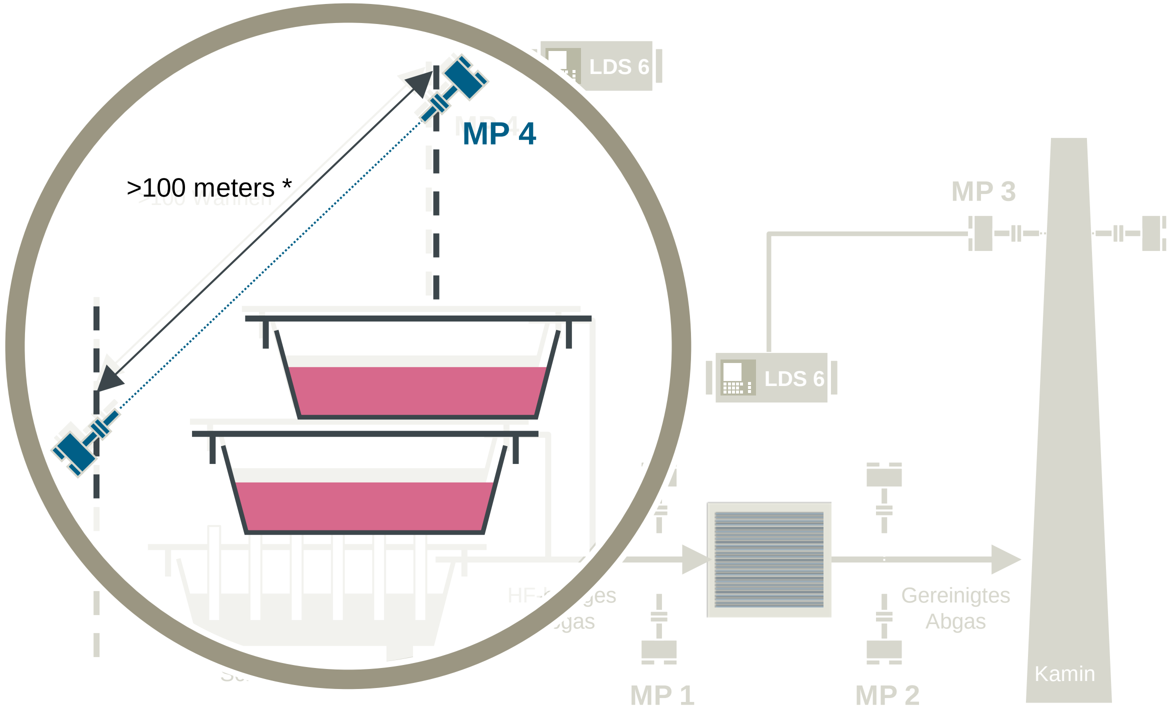
- An aluminum smelter consists of a large number (300 to 720) of pots in which the electrolysis takes place
- **Worker safety and ambient air quality concerns** require that HF be monitored at the pot room because fugitive emissions escape through the roof vents of the smelter buildings during anode changing, metal tapping, pot tending, etc.
- These fugitive emissions escape into the atmosphere without being treated. It is therefore of interest **to quantify the concentration of these emissions** in order to reduce them to the lowest practical level thereby minimizing any impact



Application solution for use case 2 – Pot room roof

- LDS 6 provides sensitivities from the **part per million-volume** meter
- LDS 6 is also capable of controlling the **emissions in an open path** measurement in the pot room (measuring spot 4)
- As path length, a measurement distance of **more than hundred meters** can be applied, which leads to truly representative HF concentration data in the ambient air



* as customized solution

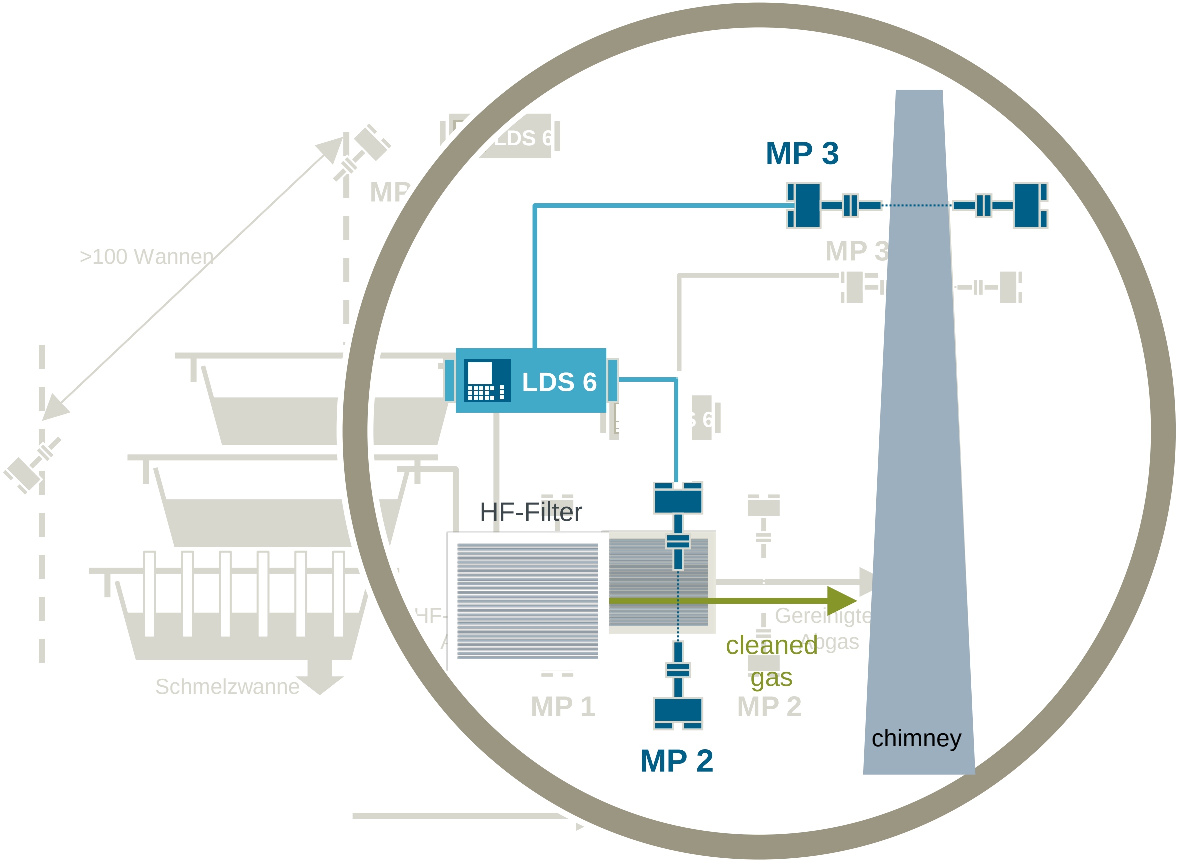
Use case 3 – Stack monitoring

Stack monitoring is also important to

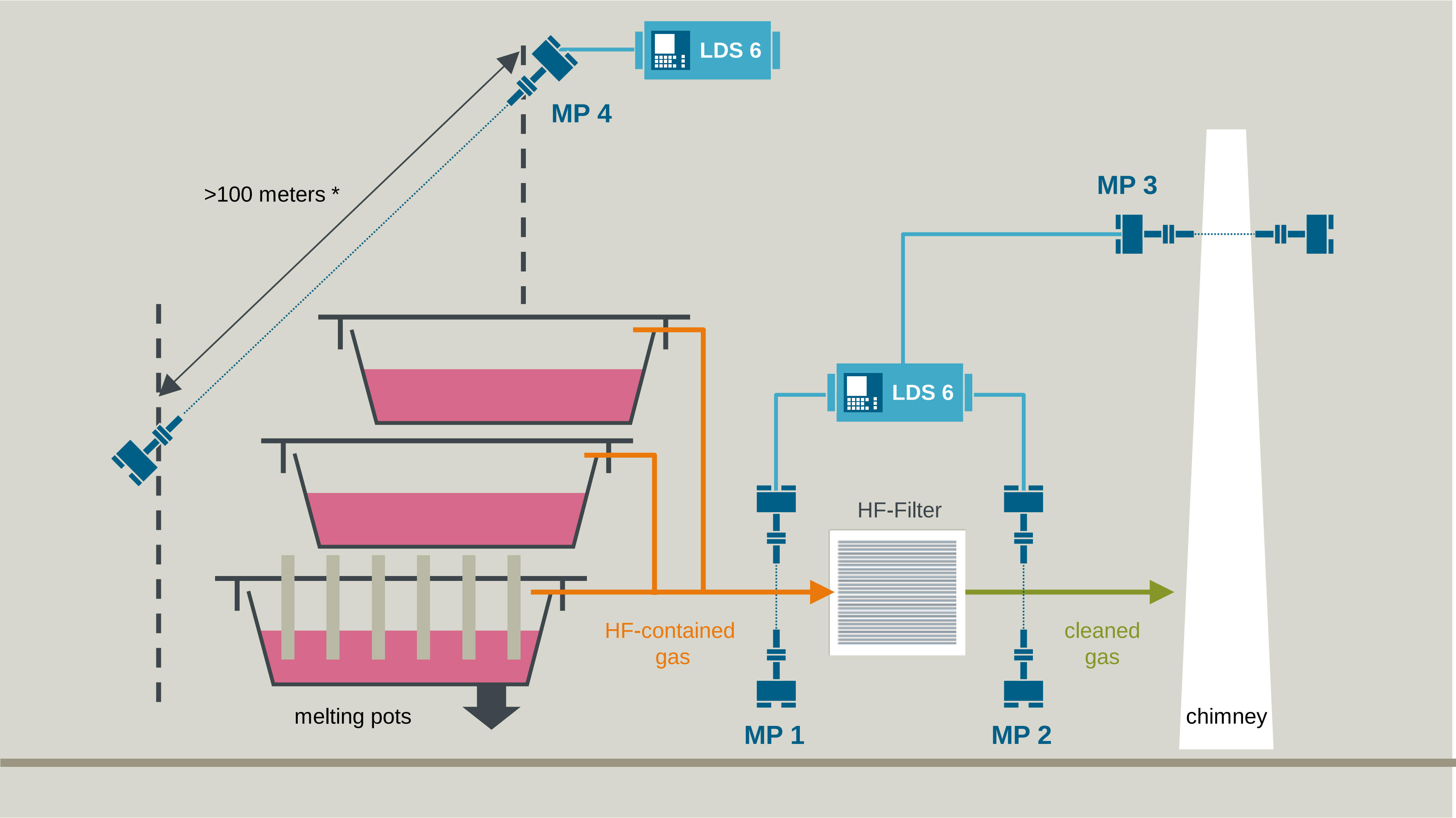
- Reduce fugitive HF emissions **to protect the environment**
- Give continuous and real-time readings to **enhance operational efficiency**
- **Safeguard people** in and around the smelters

Application solution for use case 3 – Stack monitoring

- The LDS 6 installed behind the filter (spot 2 and 3) also delivers data from the outlet duct which ensures that **environmental standards are kept**
- Range: 0-5 ppm, t<150C, P ambient



Complete application solution



- **One sort of device** for the HF monitoring throughout the whole smelter!
- Up to three measurement spots described above can be controlled with **only one LDS 6 central unit**, which is connected to the three sensor pairs via fibre optic cables

* as customized solution

Your benefits

Benefits of installing the Siemens LDS 6 in aluminium smelters

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- The in-situ gas analyzer LDS 6 is characterized by a **high availability** and **unique analytical selectivity**
- LDS 6 enables the measurement of HF **close to the essential measuring points** in hot, humid, corrosive, explosive, or toxic conditions
- LDS 6 needs **very little installation effort** and a minimum of maintenance, due to its built-in, **maintenance-free** reference gas cell that makes **field calibration unnecessarily – lifetime calibrated!**
- It provides **real-time measurements**
- **No gas sampling** of toxic and aggressive HF is necessary, the measurements are performed in-situ

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You will gain

- **Highest reliability and lowest cost of ownership**
  - No consumable parts
  - Very low maintenance
  - Verification kit available for easy, fast and repeatable checks
- HF data that is **more accurate**, and with **faster response times**
- Compliance with **Health, Safety and Environment (HSE)** regulations
- **Optimal changing cycles** of the filters and therefore lower maintenance costs!

Our Vision

Siemens PD Process Automation with comprehensive portfolio to drive Digitalization

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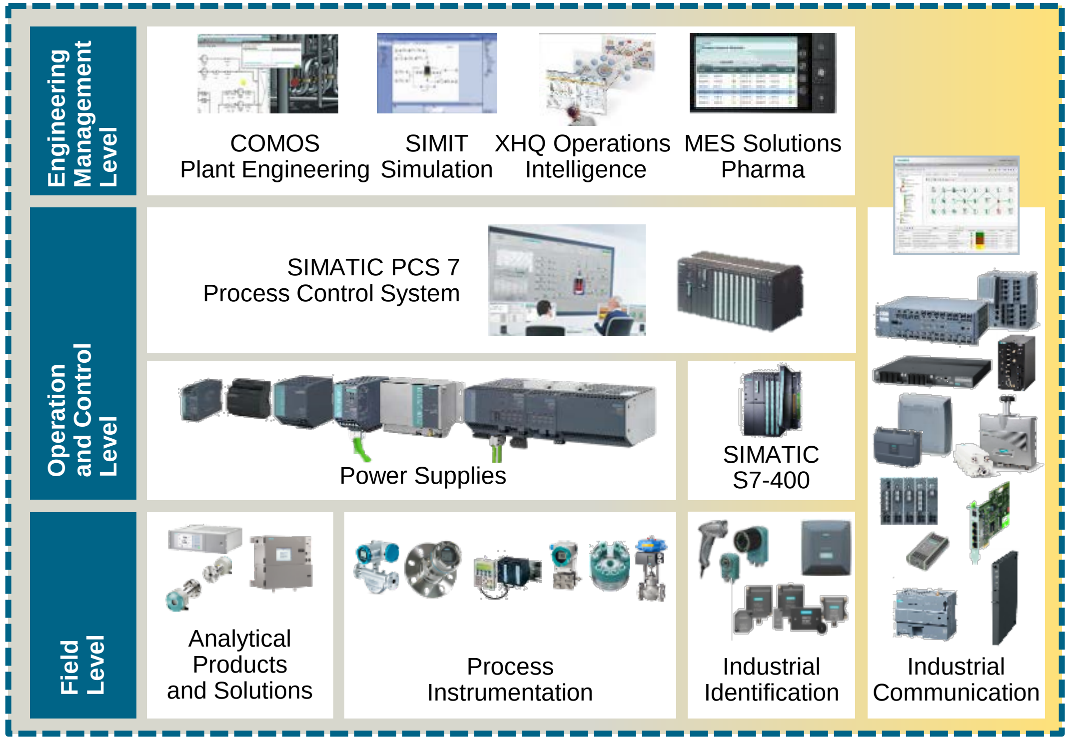
Digitalization in Process Industries → PD PA portfolio today and in the future

PD Process Automation portfolio



Technology: Hardware Software

Our vision

Engineering Management Level

- Seamless horizontal integration
- Optimization through full transparency and analytics

Operation and Control Level

- Advanced control enabling modularization, virtual control and remote operations
- System integrated diagnostics & maintenance

Field Level

- Enhanced embedded functionality
- Fully included in “as-is” digital twin based on digital connectivity
- Soft / virtualized and smart sensors

On-demand networks, real-time communication w/ easy configuration, RFID and NextGen code reading for Digitalization

Thank you for your attention!

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