Digital twins as enabler for data-driven process improvements in the industrial manufacturing of food and feed

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Innovations for a **better world**

BÜHLER

Climate change widespread, rapid, and intensifying.

The Intergovernmental Panel on Climate Change (IPCC) released the first of three installments of the Sixth Assessment Report (AR6).

CO_2 concentration

Highest in at least **2 million years**

Sea level rise

Fastest rates in at least **3000 years**

Arctic sea ice areas

Lowest level in at least **1000 years**

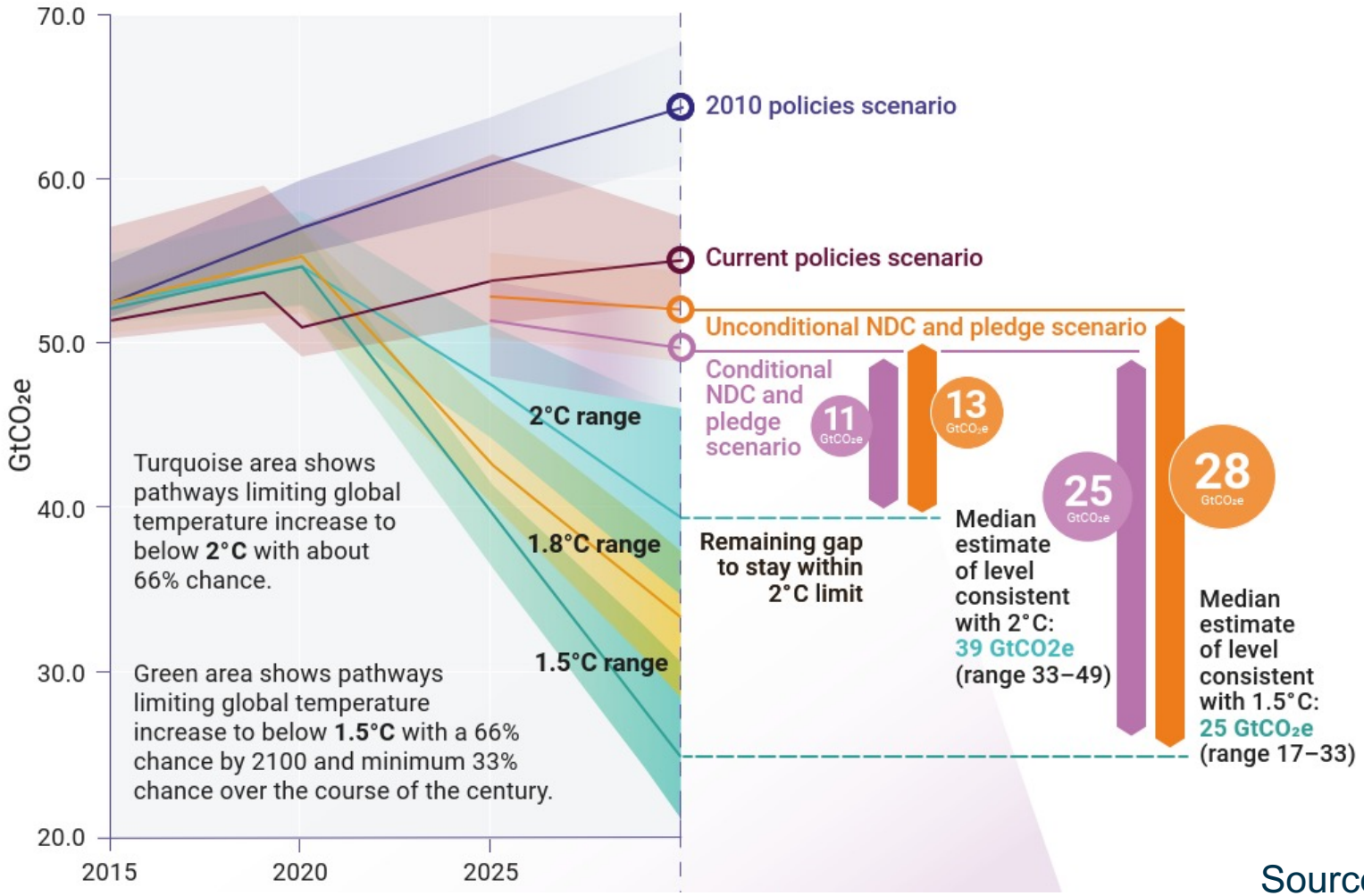
Glaciers retreat

Unprecedented in at least **2000 years**

Source: IPCC, 2021: Climate Change 2021: The Physical Science Basis.

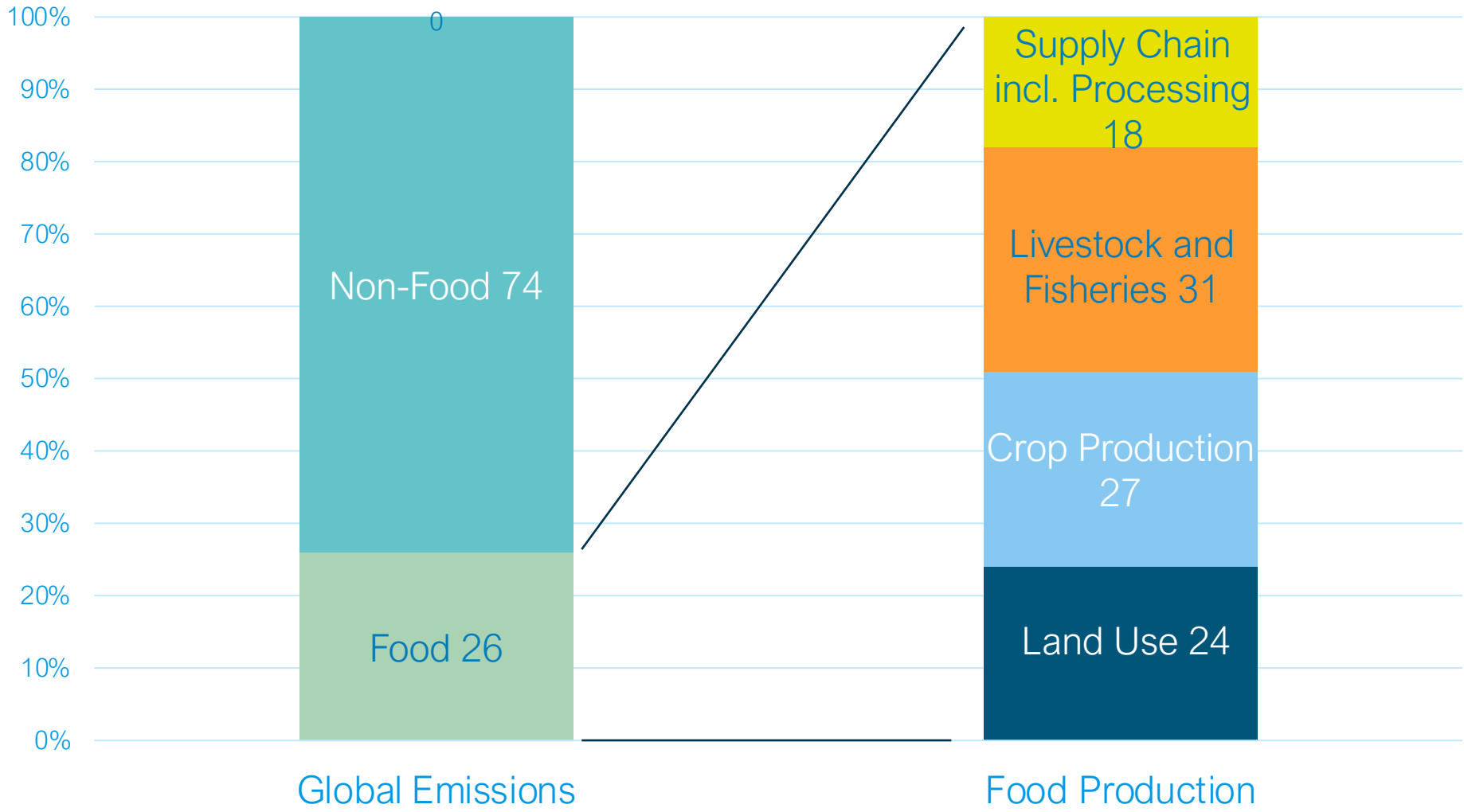
Urgency to act now to limit global warming to 1.5 °C.

Emissions need to be halved in the next 8 years.



Source: UN Emissions Gap Report 2021.

Food production responsible for 26% of global emissions



Source: Our World in Data

Our Relevance

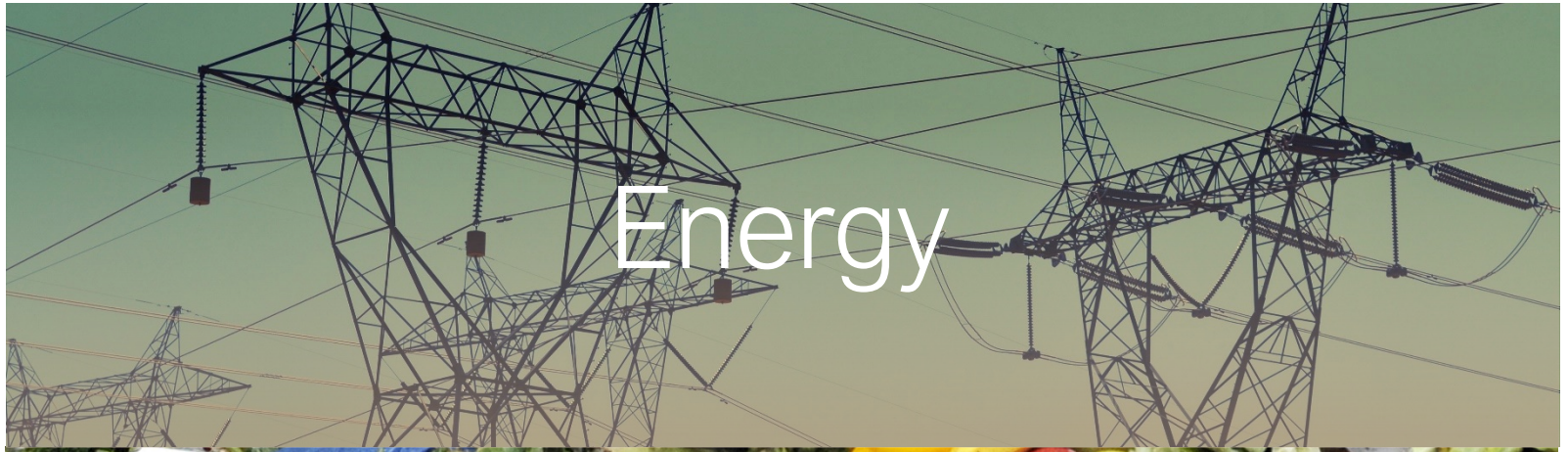
Two billion

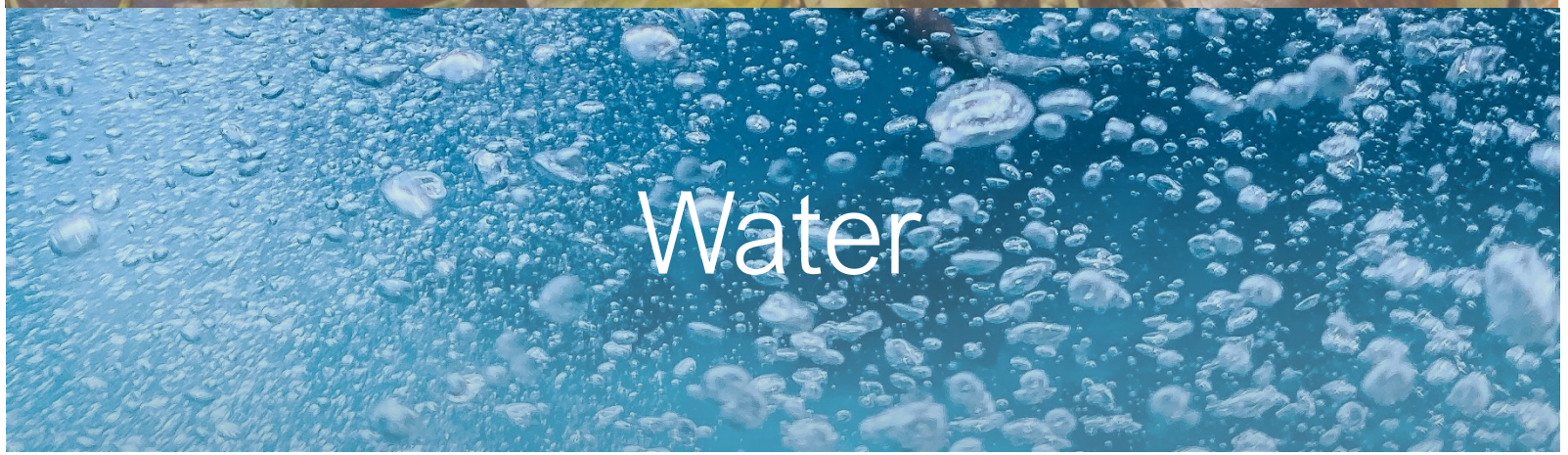
people each day enjoy food
produced on Bühler equipment

One billion

people travel in vehicles partly
produced with Bühler machinery

Our commitment
50% less



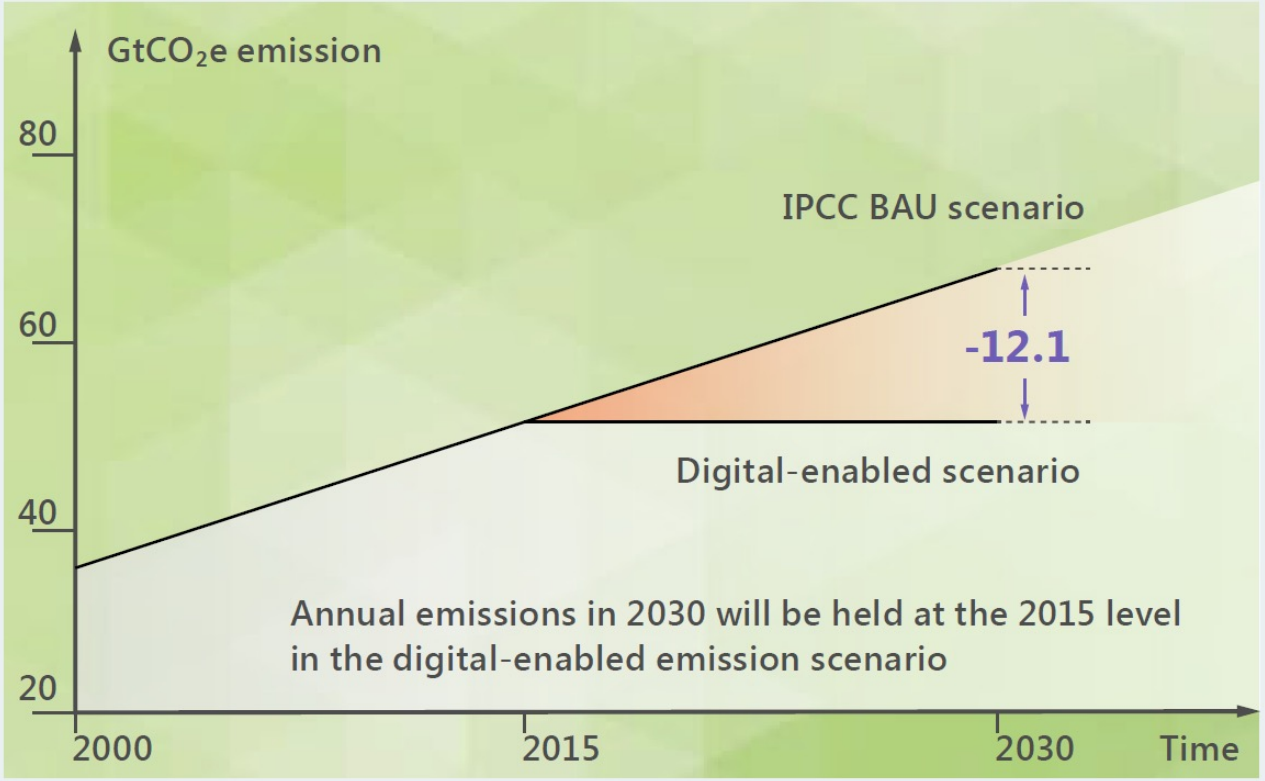


How can Digital Help?

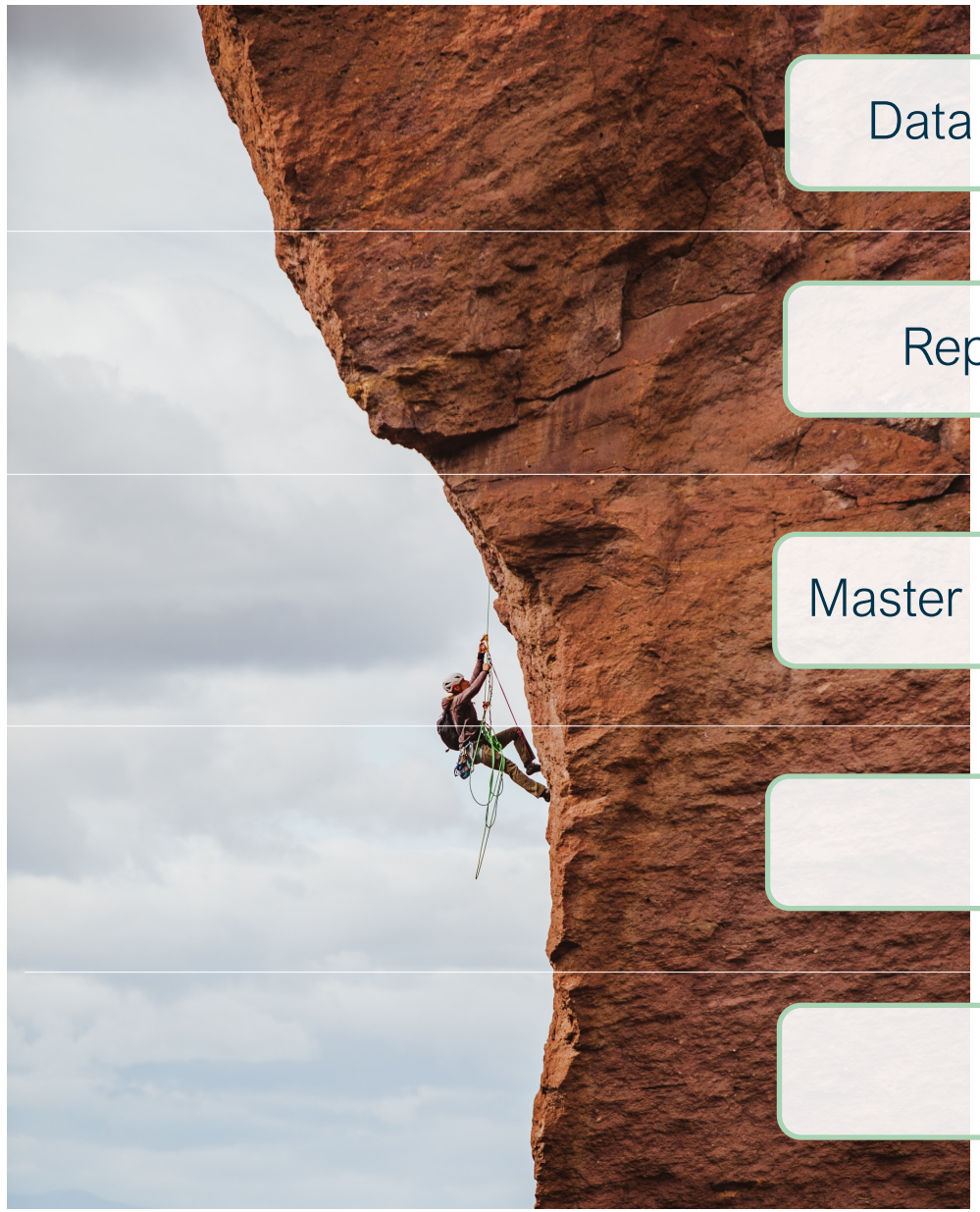
- According to the Global e-Sustainability Initiative (GeSI), ICT has the potential to slash global GHG emissions by 20% by 2030

- The data centers used to power digital services contribute approximately 2% of global GHG emissions

Digital-enabled emission reductions amount to 12.1 $GtCO_2e$ in 2030, decoupling emissions from economic growth



The Path to Data Science Maturity



Data Science, Machine Learning & AI

- Self-optimized operations
- Business transformation

Reporting & Business Intelligence

- Transparency
- Digitally enhanced services

Master Data Management & Governance

- FAIR data principles

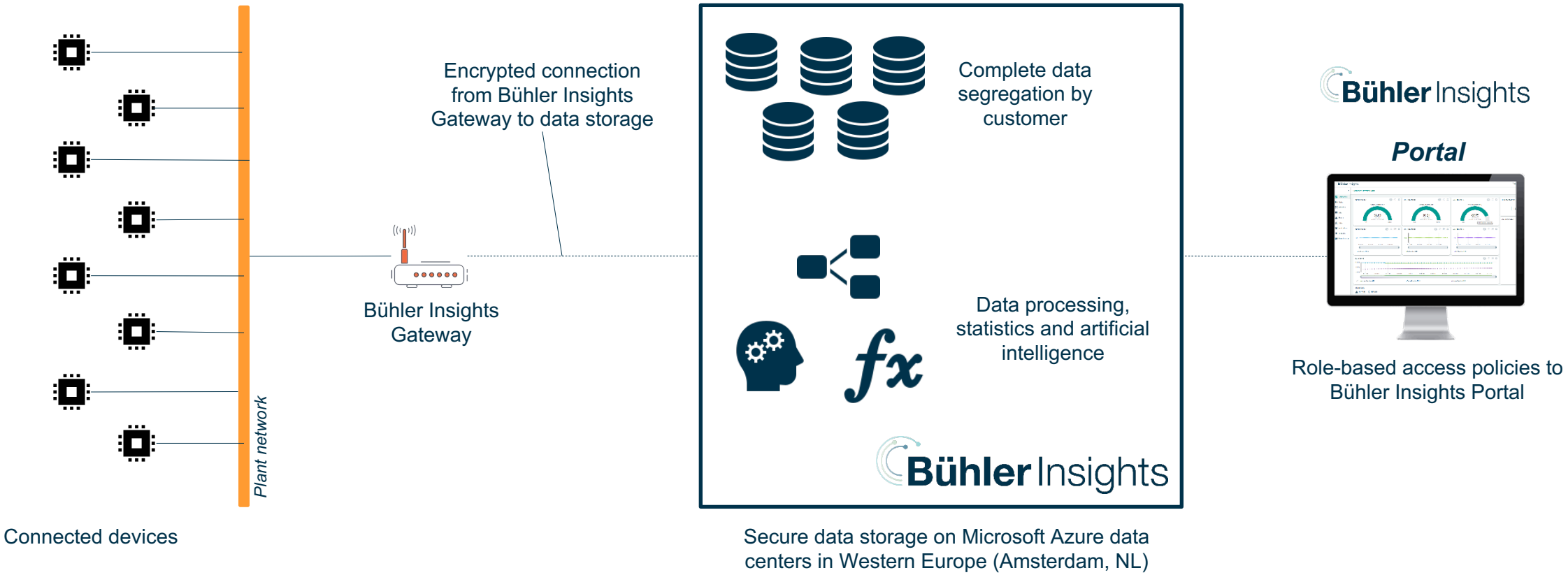
Data Engineering

- Data architecture
- Standardized APIs

Data Acquisition

- Standard connectivity solutions
- Data quantity & quality

High Level Architecture of an Industry 4.0 Cloud Platform

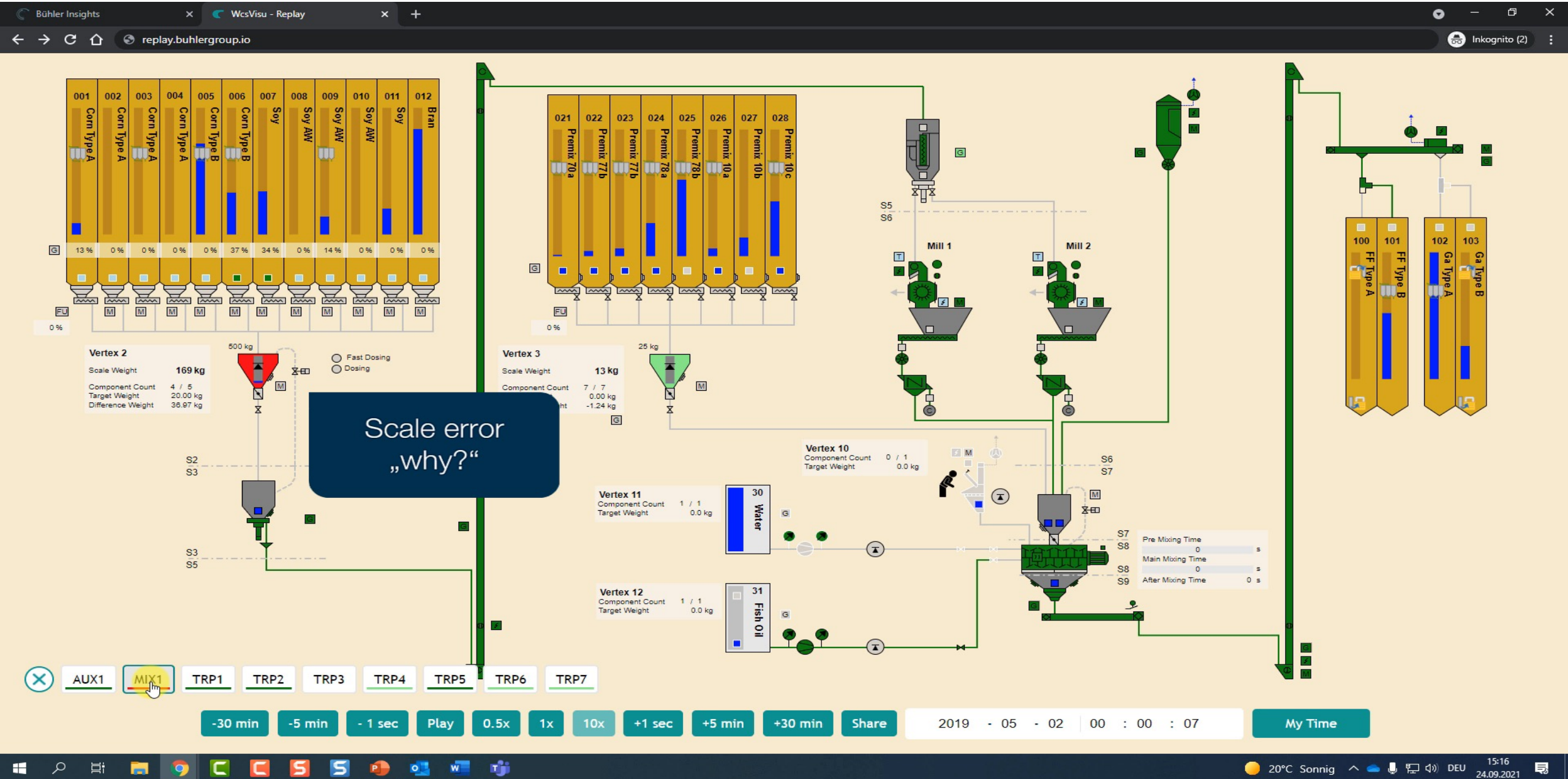


Digital Twins

Our Definition:

A Digital Twin is a sufficiently accurate representation of a physical process in the virtual space which can be used to model and optimize performance of the physical process.

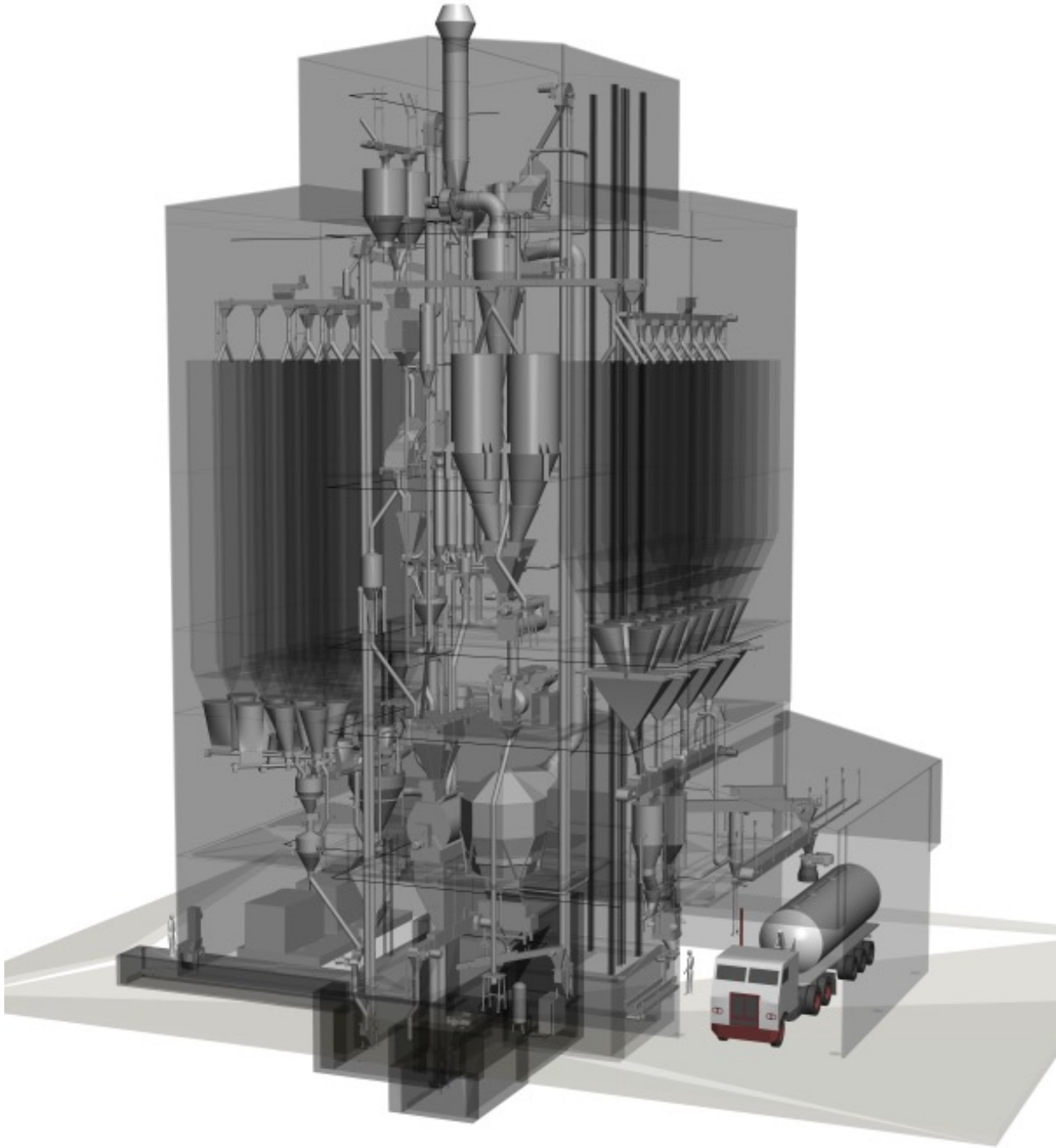
Digital Process Twin of a Dosing, Grinding, and Mixing Plant



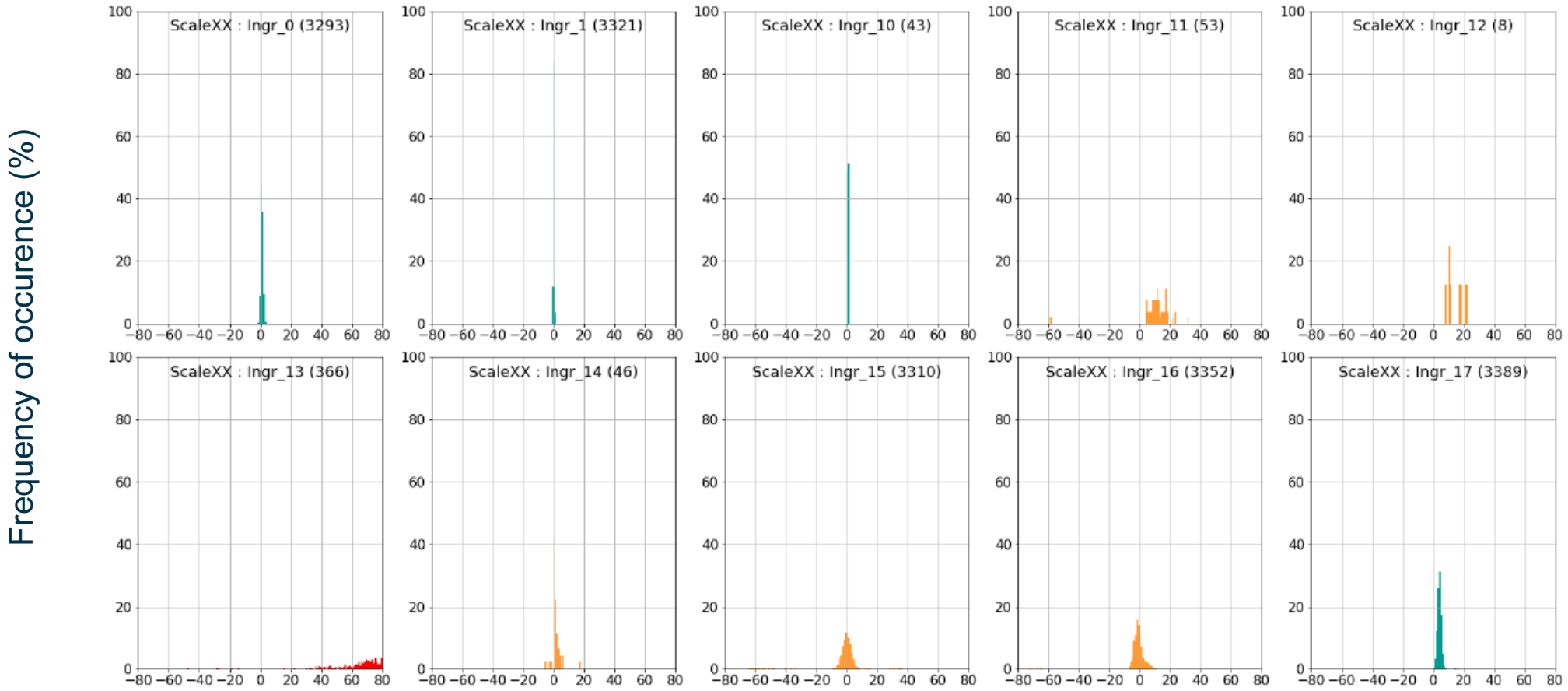
Data Driven Plant Optimization

Examples of digital optimization potential:

- **Plant performance analysis**
- **Dosing scales efficiency improvement**
- **Grinding analysis**
- **Mixing cycle optimization**
- **Pelleting line summary**
- **Inline quality measurements**
- **Error and downtime trends**



Dosing Health Monitoring

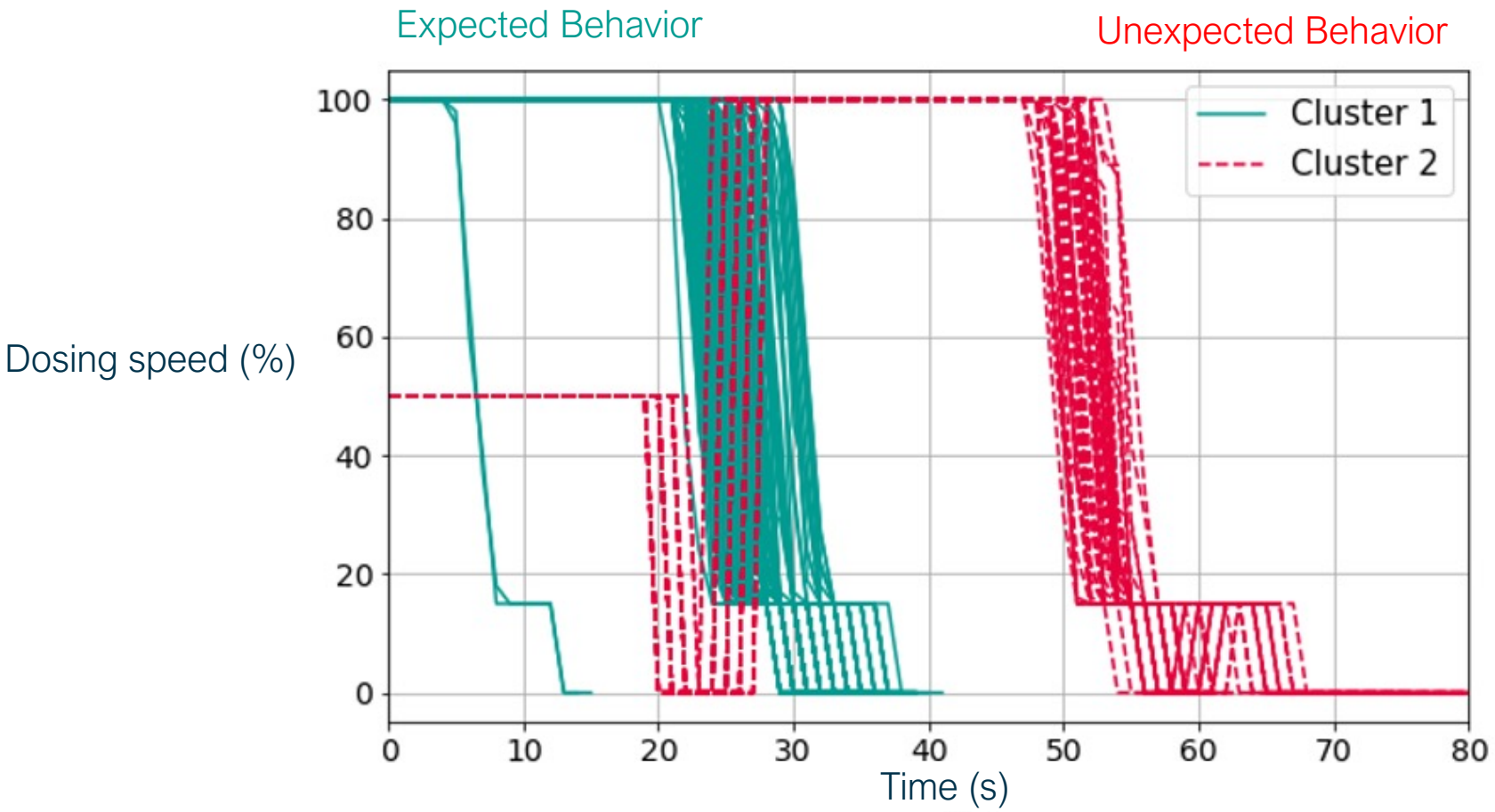


Anomaly detection with Dynamic Time Warping(DTW)

1. Compare waveforms with DTW

2. Density based clustering

3. Detect Anomalies



AI for Process Optimization

- Using Machine Learning for more resource-efficient raw material processing
- Example from Coffee optical sorting

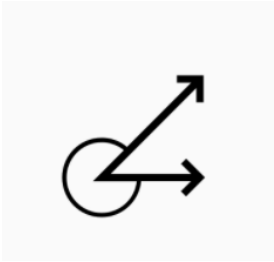
Optical Sorting

Using AI to set up optical sorters for higher efficiency

+20% higher accuracy and 3x less waste thanks to machine learning.

AI for equipment setup.

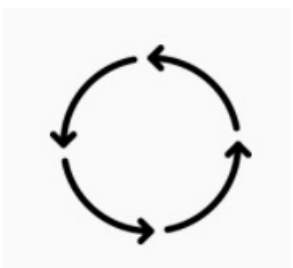
- Sorter uses shape and color features.
- No single feature provides a perfect separation between good and defective product.
- Find combination of features that provide the best possible separation.



Feature 1

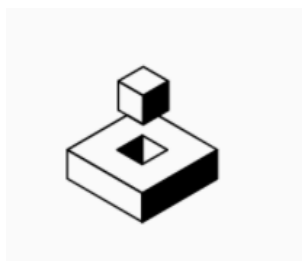
Feature 2

Feature 3



Feature 4

Feature 5



Feature 6

x

A machine learning application for shape sorting.

+20% accuracy (true negative) and 3x less waste (false negatives) using machine learning.

Precision storage

Specific energy reduction

Data services to reduce losses & CO2e / ton across installed base.

Precision sorting, cleaning & dosing

Yield increase

Summary & Outlook

- Data, Analytics and AI is a key enabler to enhance efficiency of food and feed production lines
- Small improvements can create significant impact due to large installed base of Bühler machines & lines globally
- We are further developing next-generation data-driven technologies to boost raw material efficiency and reduce energy consumption in e.g. drying processes

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Buhler Data Science Ecosystem

SDSC

Microsoft

EPFL Innovation Park

ETH zürich

Arcanite

aupa.io

INNOVATIONS FOR A BETTER WORLD