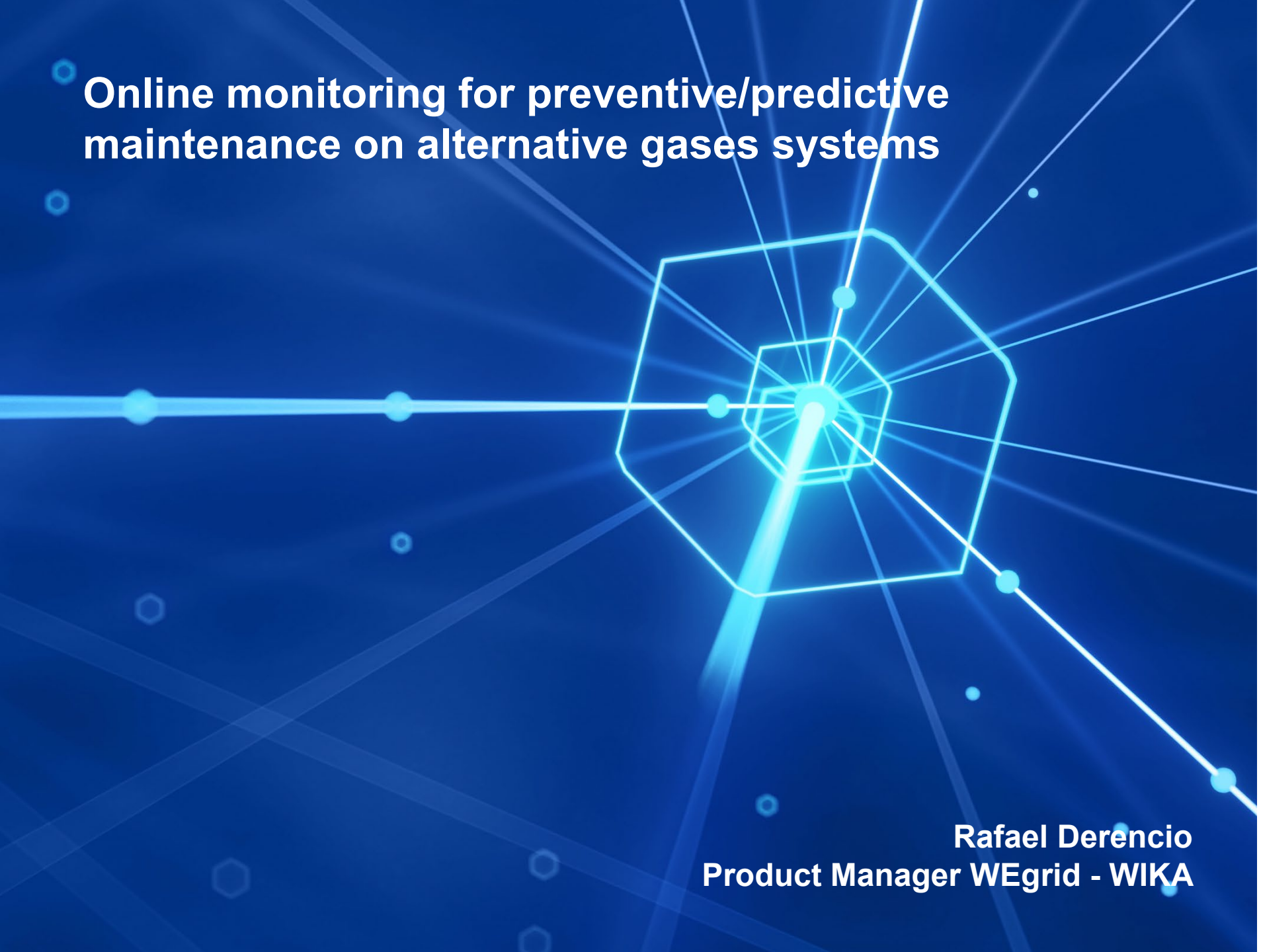
Online monitoring for preventive/predictive maintenance on alternative gases systems



Rafael Derencio
Product Manager WEgrid - WIKA

REASONS FOR

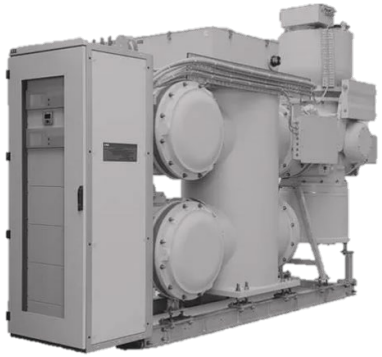
Failures on MV and HV switchgears

Air insulated

- Dust
- Dirt
- Contact resistance
- Overload

Gas insulated

- Gas Leakages
- Humidity
- Decomposition products



HOW TO PREVENT

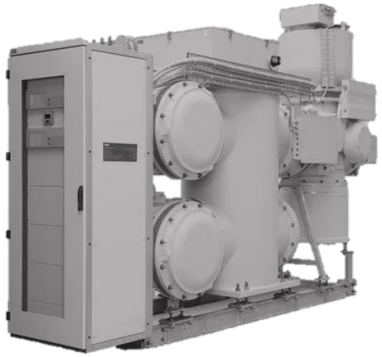
Failures on MV and HV switchgears

Air insulated

- Partial Discharge Status
- Temperature
- Humidity

Gas insulated

- Pressure
- Temperature
- Density
- Humidity



The problem

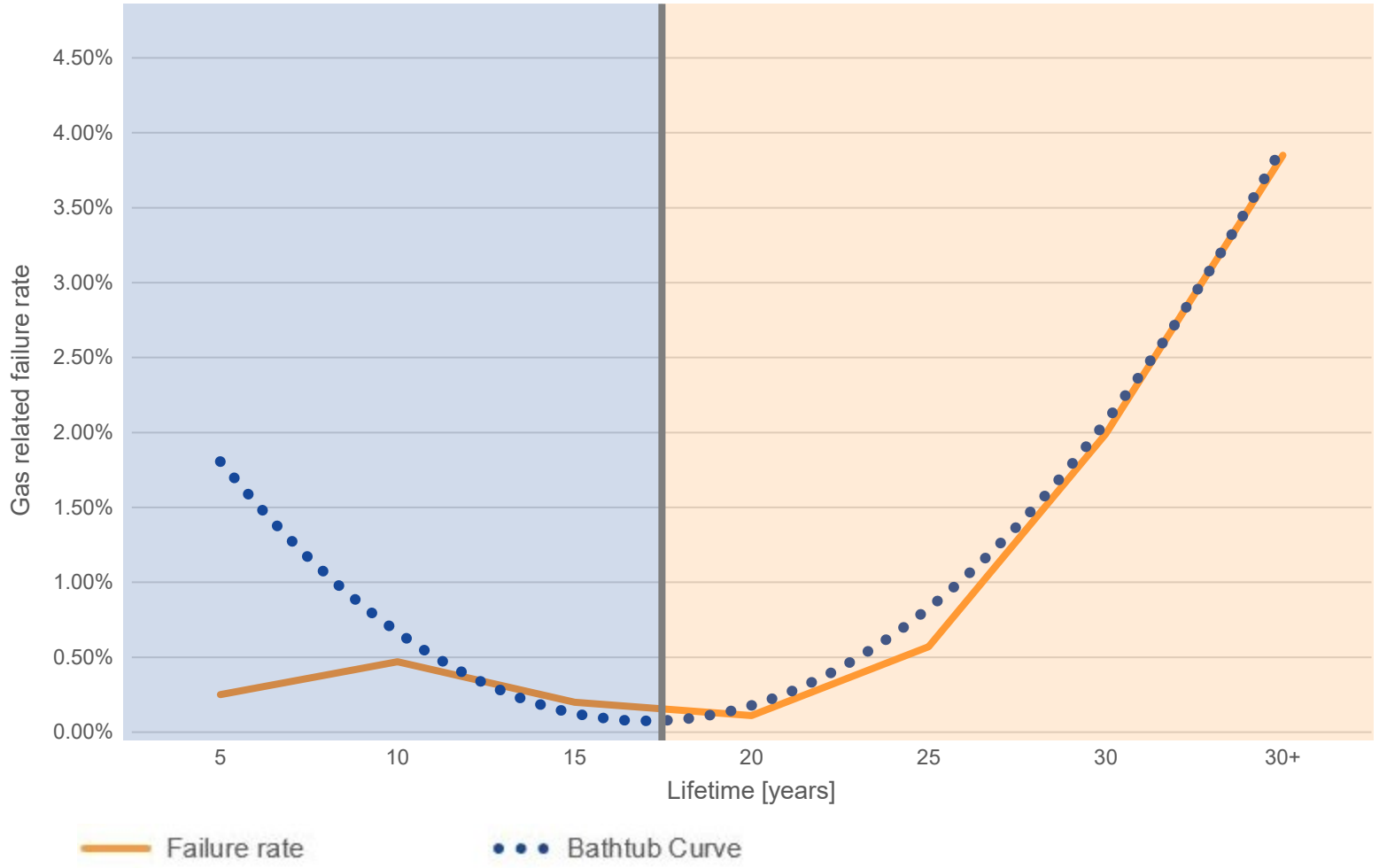
Gas Insulated Equip. Life Spam:

20 – 50 years

Considerable Increase on gas related failures:

Between 15 and 20 years after installation

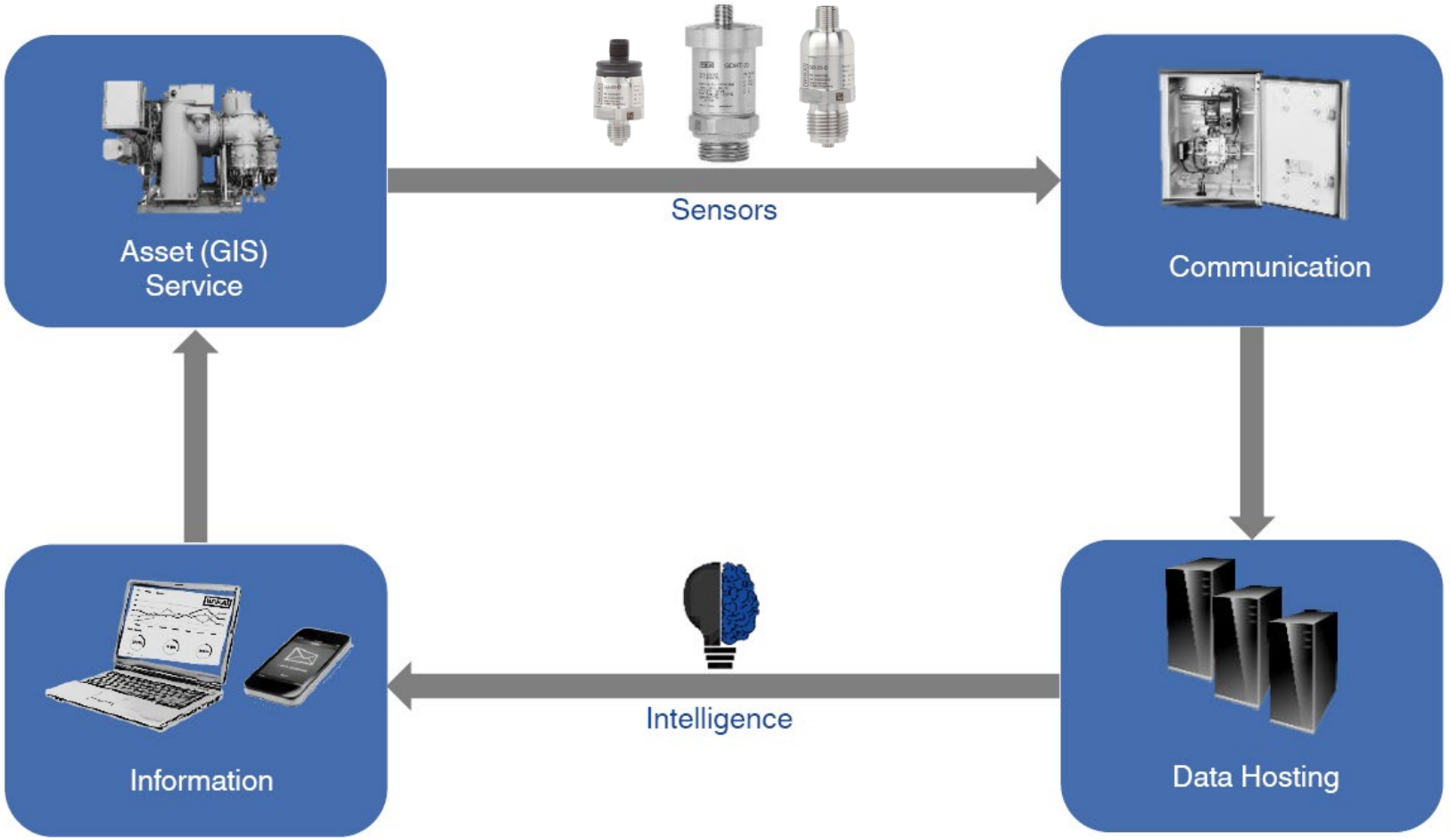
Second half of a GIE lifetime can be strongly affected by failures



Data provided by a major European TSO
Total number of Gas compartments: 33.041

ASSET PROTECTION

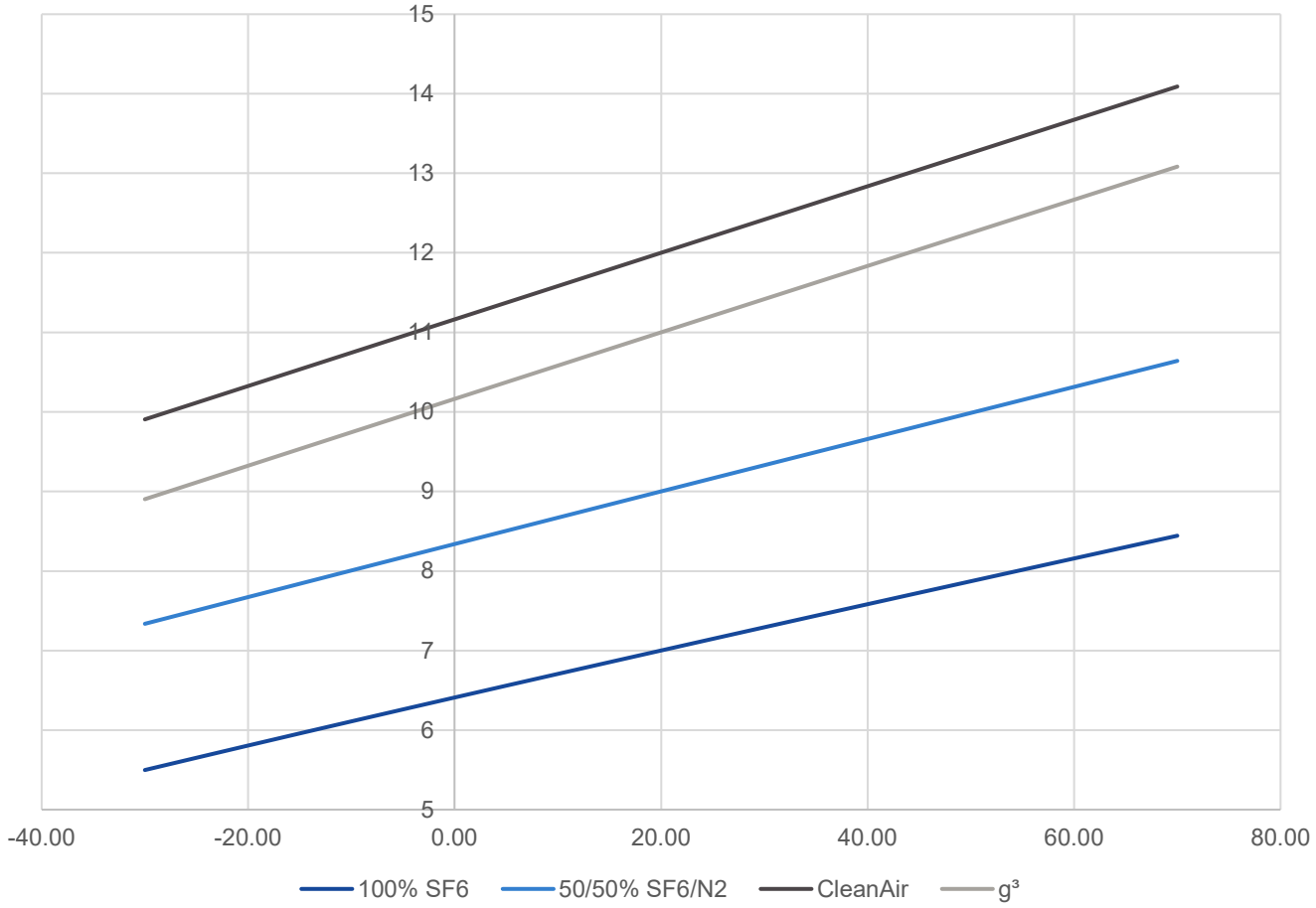
Big Picture



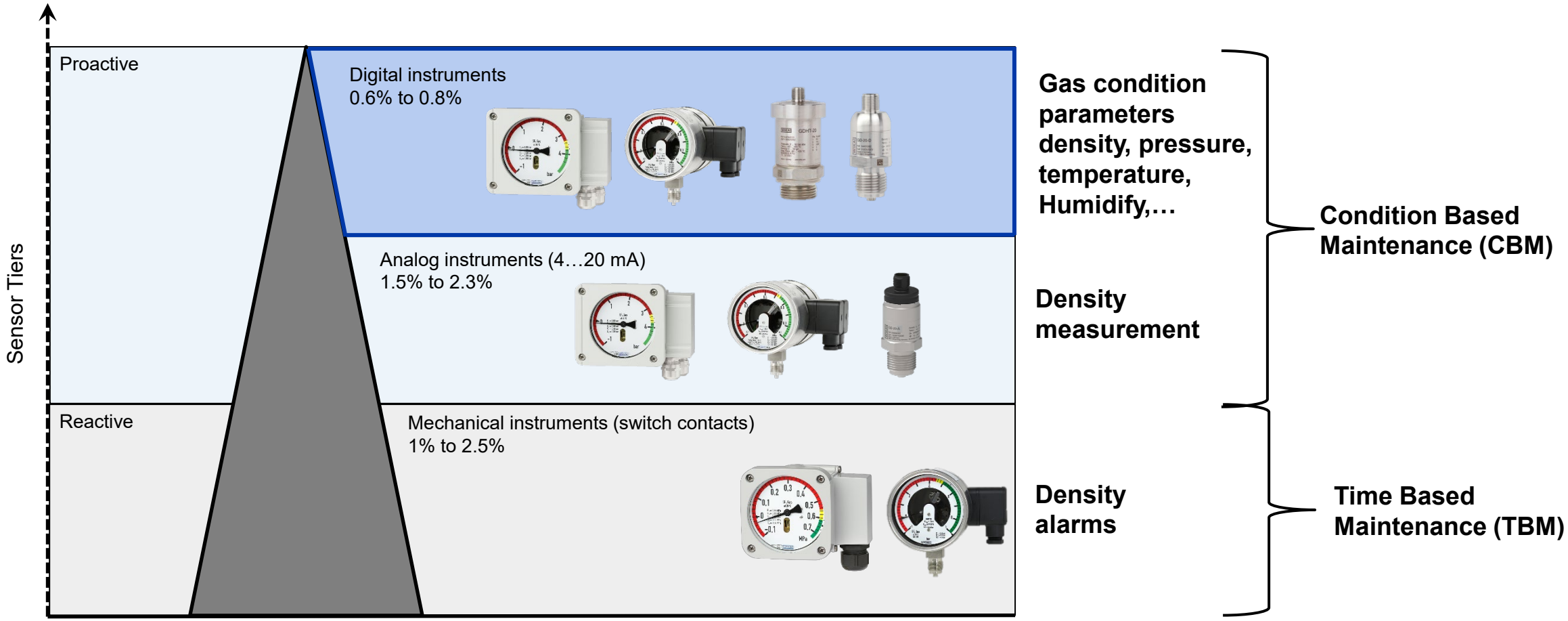
Enabling Technology - Density measurement for alternative gases

- Sensors based on temperature and pressure technology can be adapted for different gases with the proper configuration

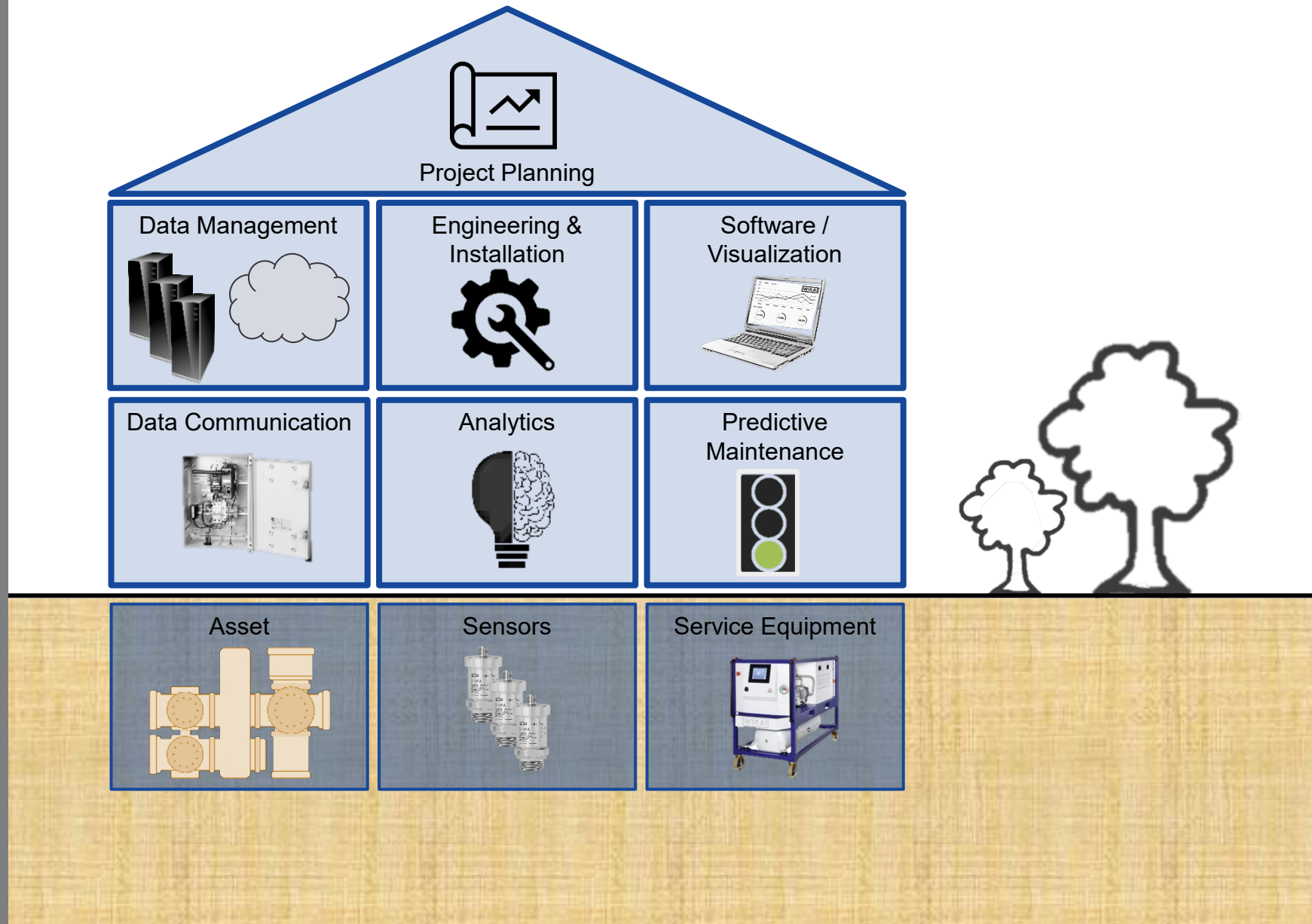
- The general behavior (slope of the curve/line) of the gases are comparable, despite different operating pressures, but still needs minor adjustments for higher accuracy



Sensors Tiers for Asset Monitoring



Setup


Project Planning
Data Management
Engineering & Installation
Software / Visualization
Data Communication
Analytics
Predictive Maintenance
Asset
Sensors
Service Equipment

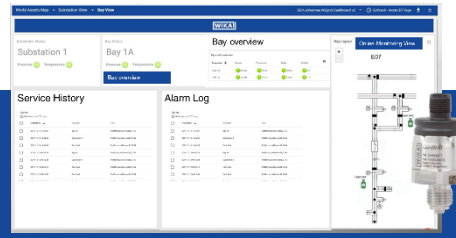
Technology Transformation

Density:
Gas density monitoring systems with alarm contacts and manual reading

Humidity:
Gas analysis every 1-6 years manually with test instrument

Activity based Asset Information

Transformation



Density:
Live measurement and forecast

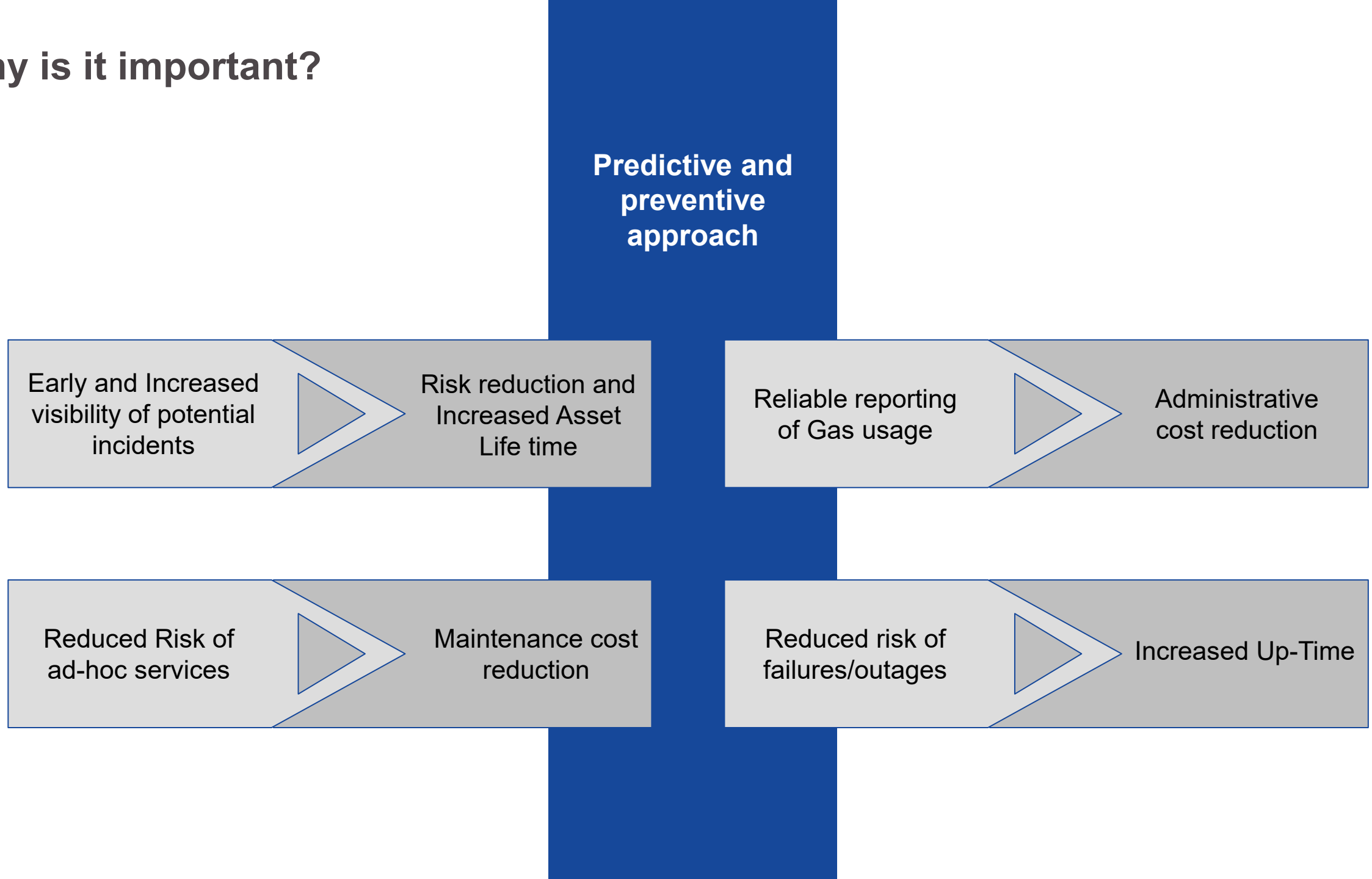
Humidity:
Live measurement and forecast

Online Monitoring

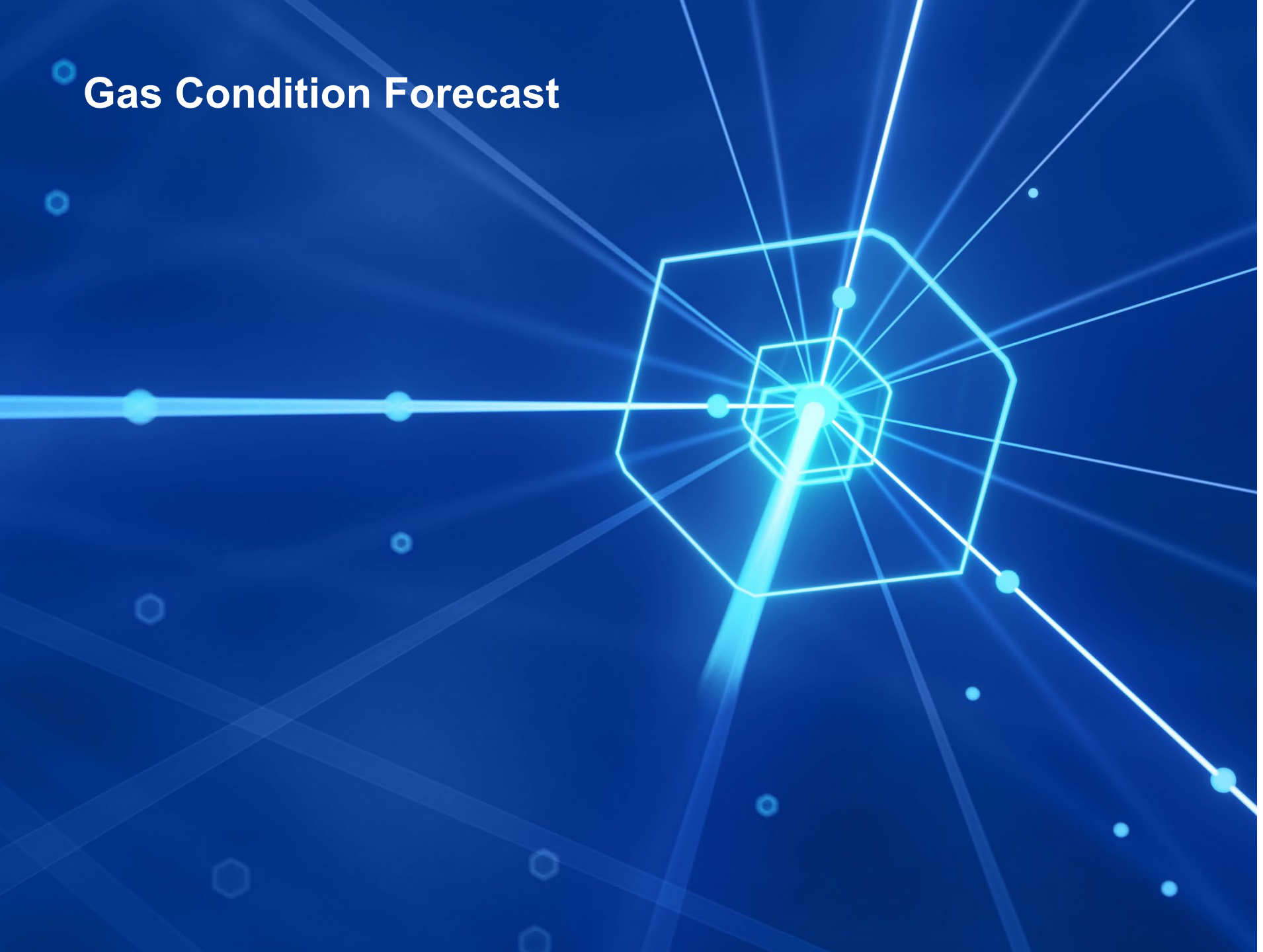
Past

Today

Why is it important?



Gas Condition Forecast



Gas Condition Forecast

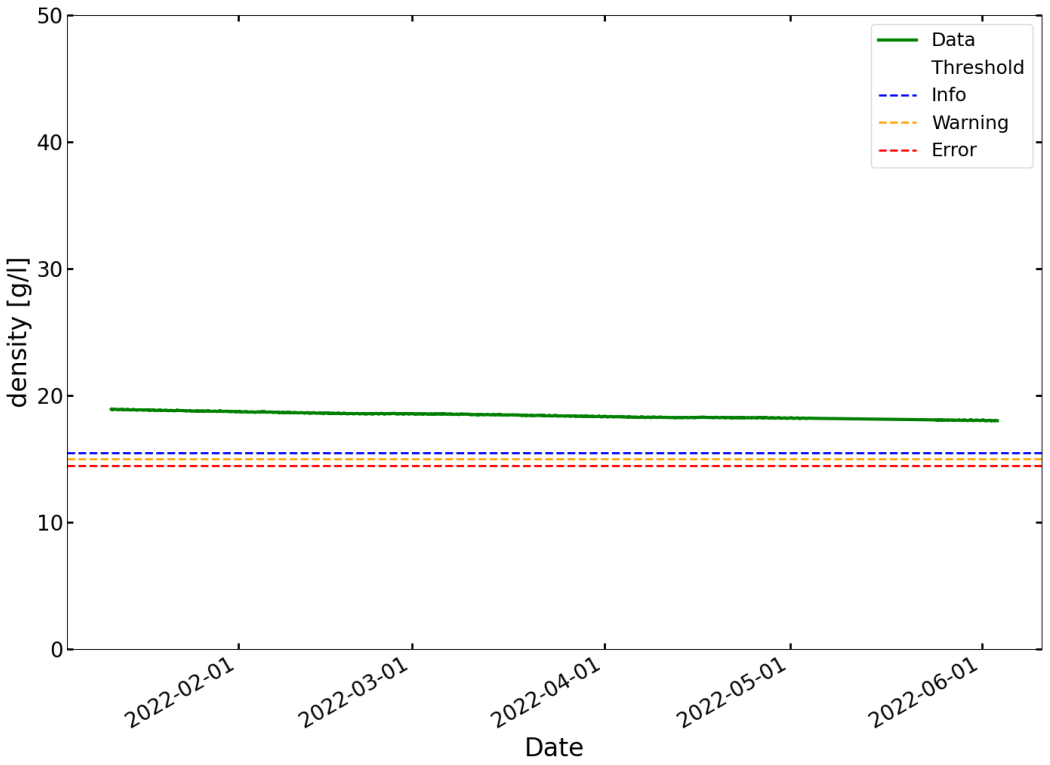
Introduction

- Provide the operator a reliable picture of the condition and evolution of an asset

    1. Continuous monitoring is the basis
    2. Raw measurements can give rise to misjudgment
    3. Gain deeper understanding based on historical data
    4. Use this knowledge for further interpretation

- Predictive maintenance can replace scheduled maintenance
    1. Decrease costs for operator
    2. Decrease risk of Gas-related failure

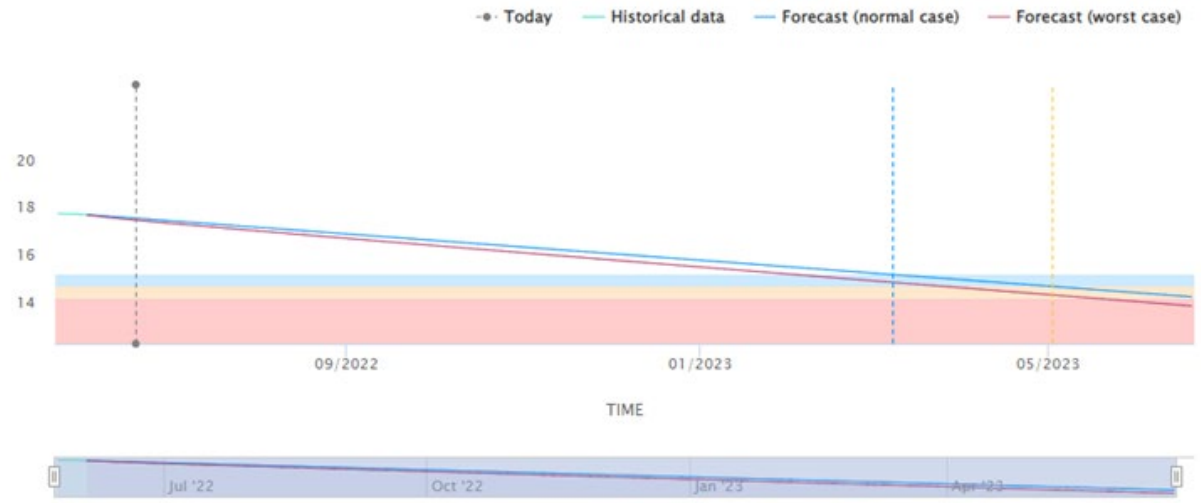
Density Forecast



- Changes in density (and humidity) are hard to detect when only measurements are taken every now and then
- Continuous measurements are crucial to understand the condition of the asset

Density Forecast

- Forecasts based on time series models which take into account correlations between past and present
- Density forecast is represented by the expected evolution (normal case) and a worst case (95% confidence interval)
- Forecast is validated by studies on real sensor data from the field and simulations
- Forecast accuracy strongly depends on amount and quality of the data
- Functionality to constrain data which data should be used for the forecast calculation

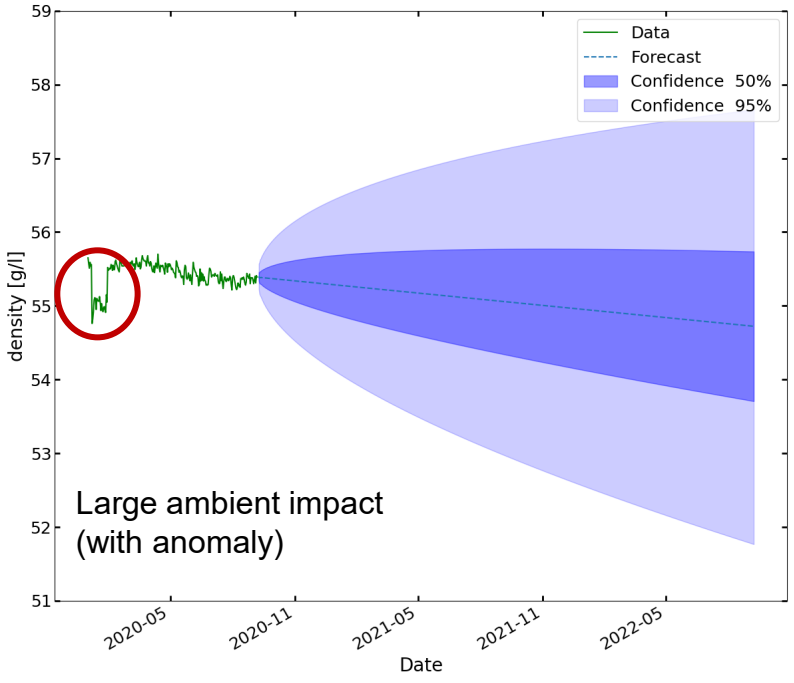


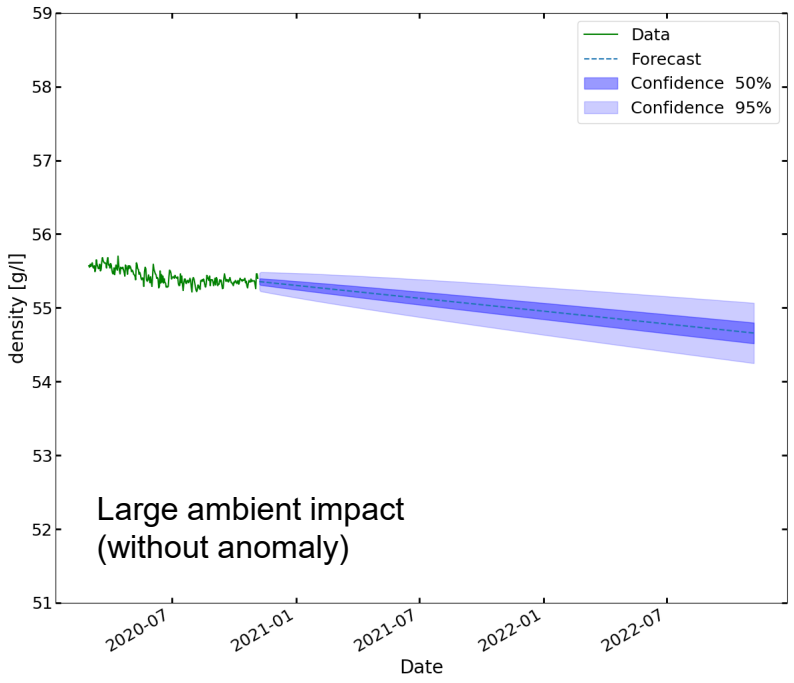
Severity	Days until threshold is reached - worst case	Days until threshold is reached - normal case
▲	331 days	371 days
⚠	279 days	316 days
ℹ	228 days	261 days

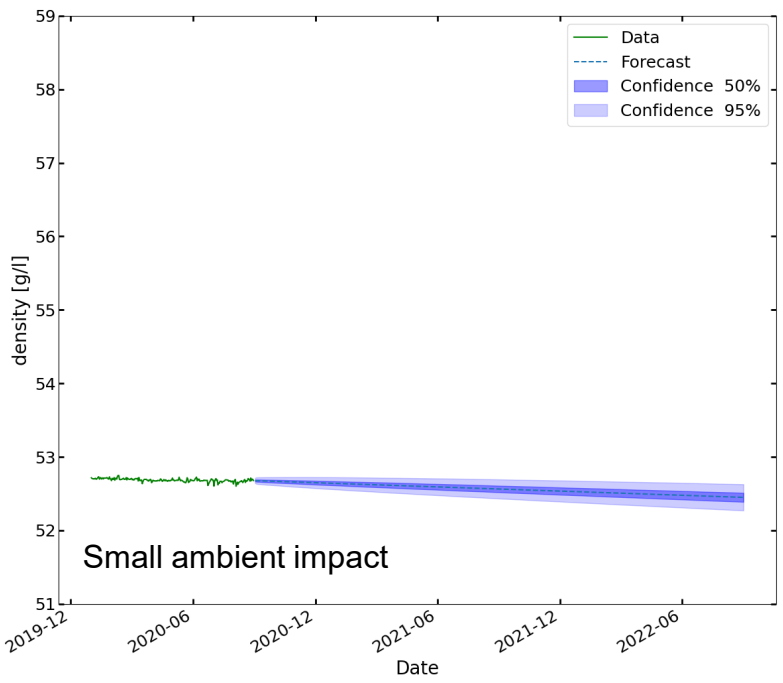
From the cloud application

Importance of data quality for forecast precision

- Data quality has a significant impact on the precision of the forecast
  - *Sensor accuracy and consistency is very important!*
- Anomaly and event detection can be an important pre-processing step

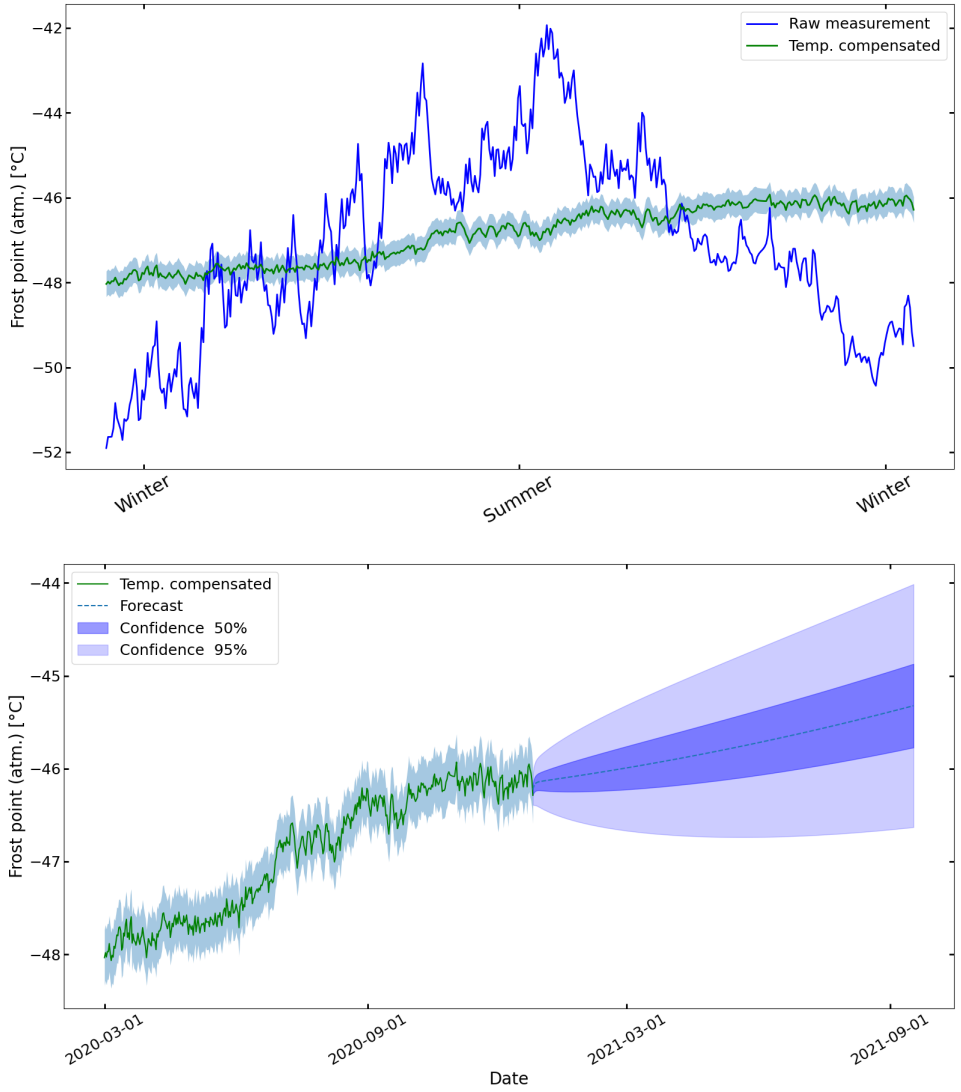






Humidity scaling and forecast

- Humidity has a complex correlation with the ambient temperature
- The humidity condition of an asset can be misjudged when only taking into account raw humidity measurements
- Every compartment has a unique correlation between humidity and temperature, which can be extracted from historical data and compensated
- This temperature compensated value can be forecasted



Event detection/creation

Maintenance can affect the precision of the results of data analytics (active de-humidification, top-up, …)

On the platform, these events need to be automatically identified so that appropriate action can be taken

- Detect and identify anomalies and events to remove or correct these time ranges
- On web platforms, these events can automatically be identified or created by the user
- Event history for each compartment is available on the platforms

Questions?

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