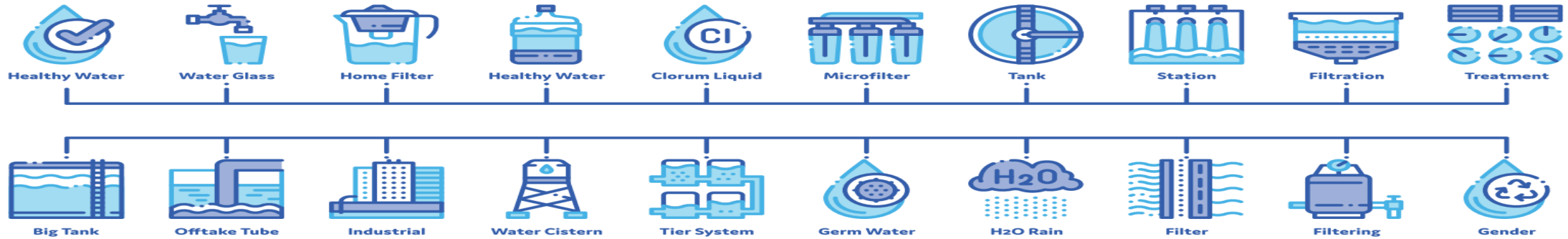


# What if underestimating sturdy sensor inputs actually prevented you from saving big on ENERGY?



20th April, 2021 Tuesday 3.00pm to 4.00pm SGT



## Topics covered:

How COD, NH<sub>4</sub> and NO<sub>3</sub> levels can be derived and better understood from data you already acquire, own and probably underestimate.

How you can switch from "Pictures" - sample analysis at given time and places - to "Movies" - streamlined information 24/7 anywhere in your plant.

Why better understanding the evolution of key process parameters in your plant has welcome side effects and how to reap those benefits.

# WELCOME

Opening & Closing: Singapore Water Association

Speaker: Antoine Walter

Senior Business Development Manager

Waste Water Treatment of GF Piping Systems HQ

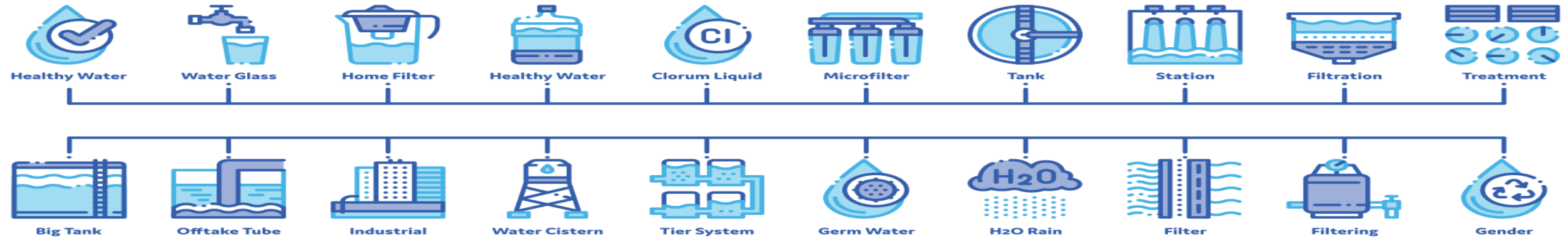
Q&A: Christine Yap

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# What if underestimating sturdy sensor inputs actually prevented you from saving big on ENERGY?

**+GF+**  
20th April, 2021 Tuesday 3.00pm to 4.00pm SGT



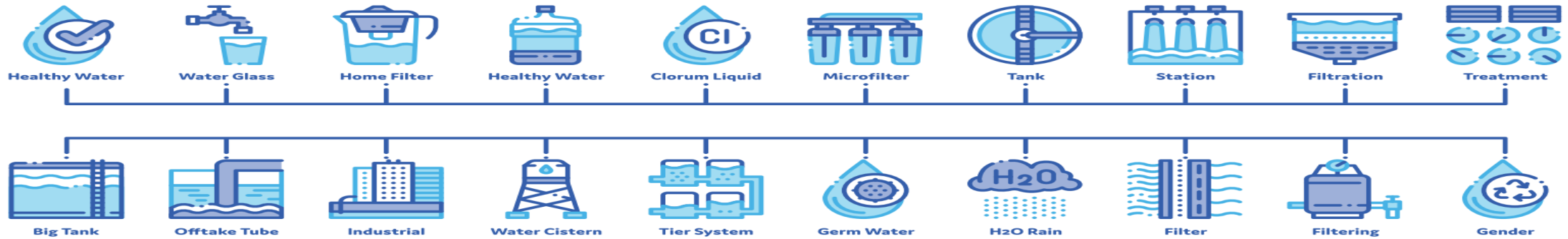
## HOUSEKEEPING

- ✓ To ensure better connectivity, please mute your microphone and turn off the camera. You may communicate with us after the event.
- ✓ Please share your questions in the chat where we will try to provide answers where possible in the Q & A Segment.
- ✓ Do identify yourself so we can respond to any unanswered questions
- ✓ We will be recording this session and reserve the rights to the video
- ✓ Please complete a post event survey which upon return, we will forward the recording and presentation deck to the respondents.

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## DISCLAIMER

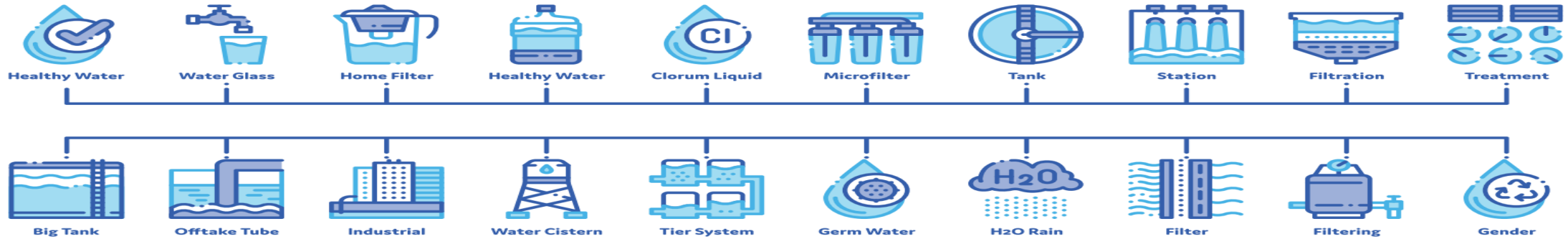
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# What if underestimating sturdy sensor inputs actually prevented you from saving big on ENERGY?



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## Speaker

Antoine Walter

Senior Business Development Manager

Waste Water Treatment of GF Piping Systems HQ



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20 April 2021

***What if underestimating sturdy  
sensor inputs actually  
prevented you from saving big  
on energy?***

Antoine Walter - SBDM Wastewater Treatment



# "Hundreds of sewage leaks



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Science

Hundreds of sewage leaks detected thanks to AI

By Victoria Gill  
Science correspondent, BBC News

Search

International edition

The Guardian

AI reveals 1,000 'dark discharges' of untreated sewage in England

Paper says machine learning could prove crucial tool in efforts to improve quality of country's rivers

THE TIMES

## Public were not warned about massive sewage spills in Thames

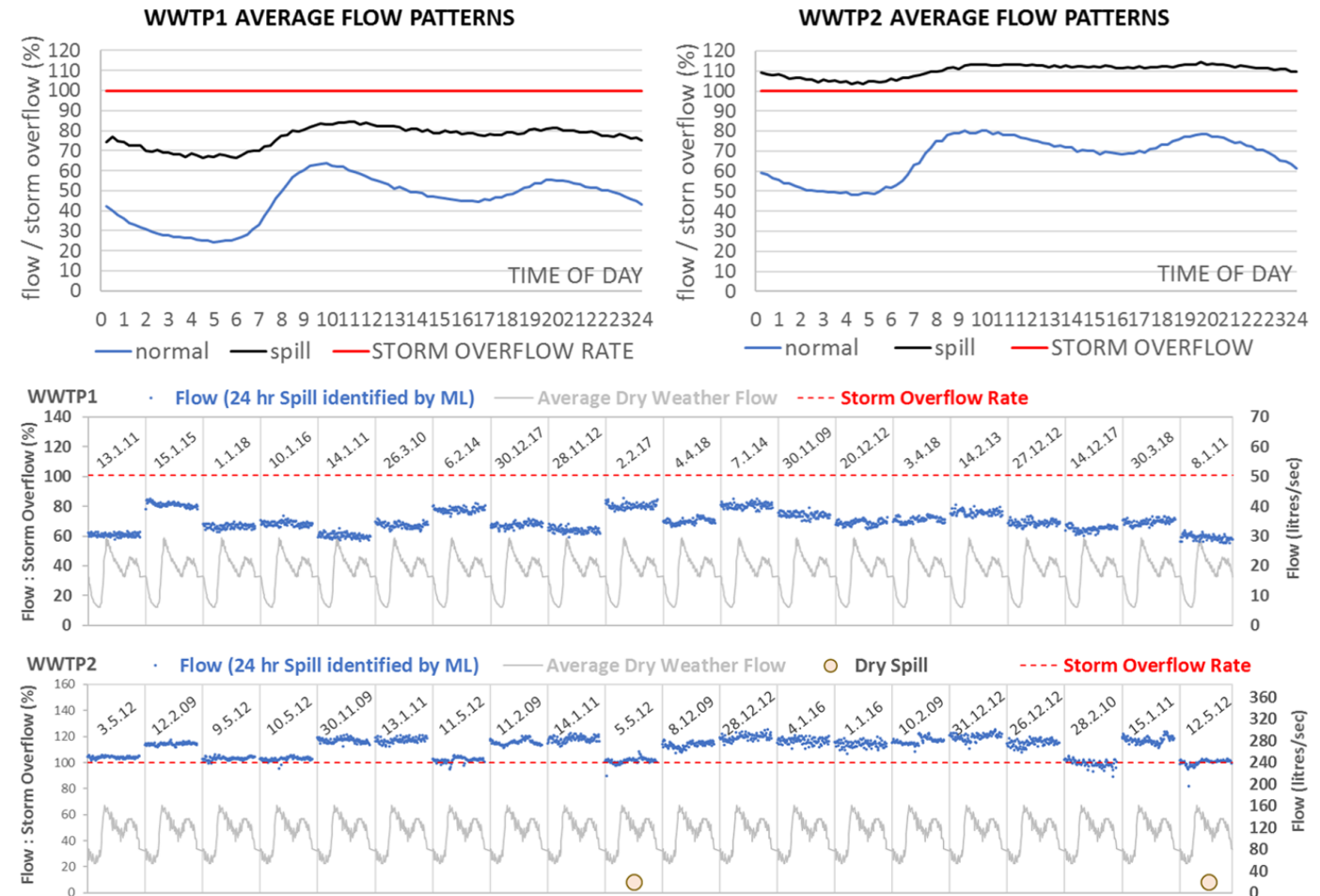
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# What happened?

- 926 "Spill events" over 11 Years
  - On two well operated plants
  - In a highly regulated and controlled country
- ... Finally detected through a Machine Learning analysis of the plant's flow
  - Shape recognition of a "Flattened" curve

Hammond, P., Suttie, M., Lewis, V.T. *et al.* Detection of untreated sewage discharges to watercourses using machine learning. *npj Clean Water* 4, 18 (2021).

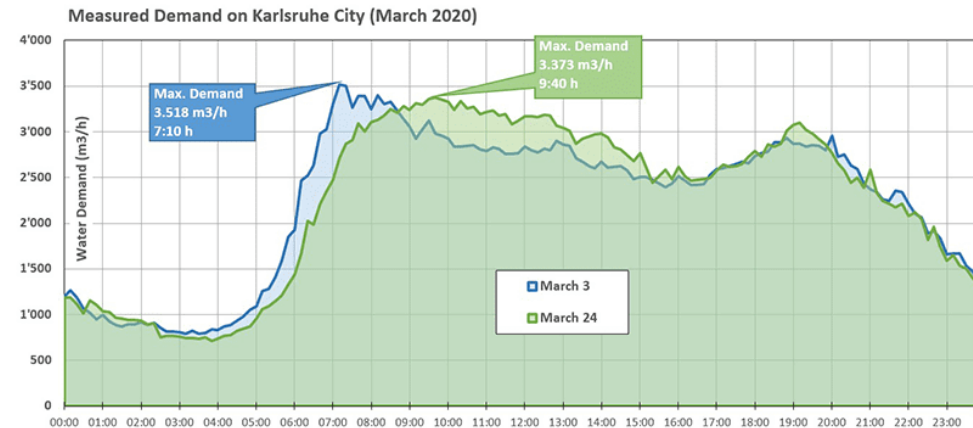
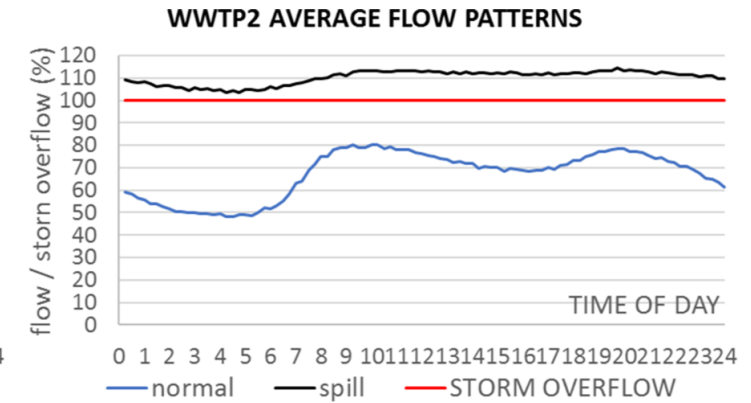
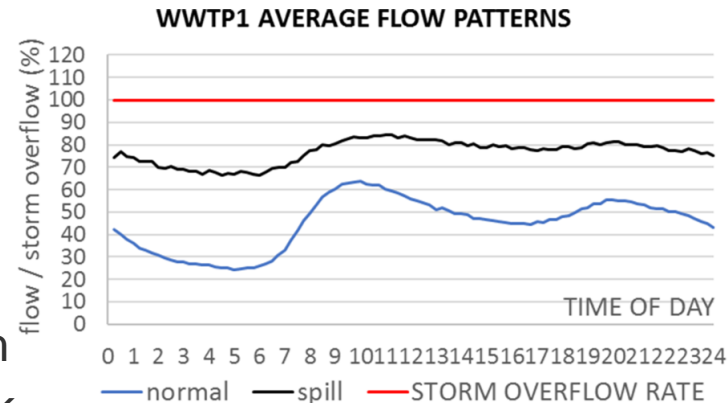
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# Could operators detect such events?

- YES!
- ... but only if:
  - They're expecting spillage
  - They know in advance where to watch
  - They have time to dedicate to this task
  - They know the pattern they shall detect
    - What if the pattern changes?
- There is an untapped optimization potential in Wastewater Treatment Plants, that needs capabilities beyond the human brain



Source: Stadtwerke Karlsruhe (2021).



# Is Big Data Crazy?



- **20%** of the songs available on Spotify were **never** listened to



Burbn (that became Instagram)



- "Burbn" enabled you to check in at some locations (and, among 20 other features, to **share pictures**)



YouTube

- YouTube was built as a **video dating site**

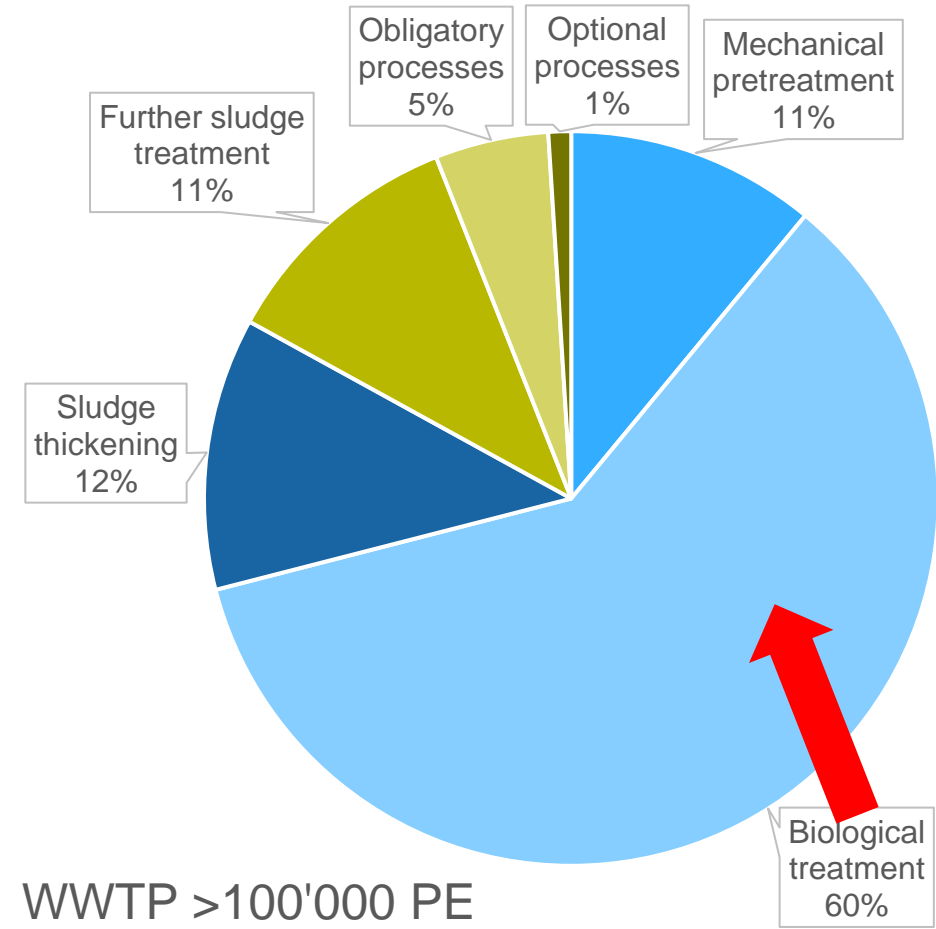
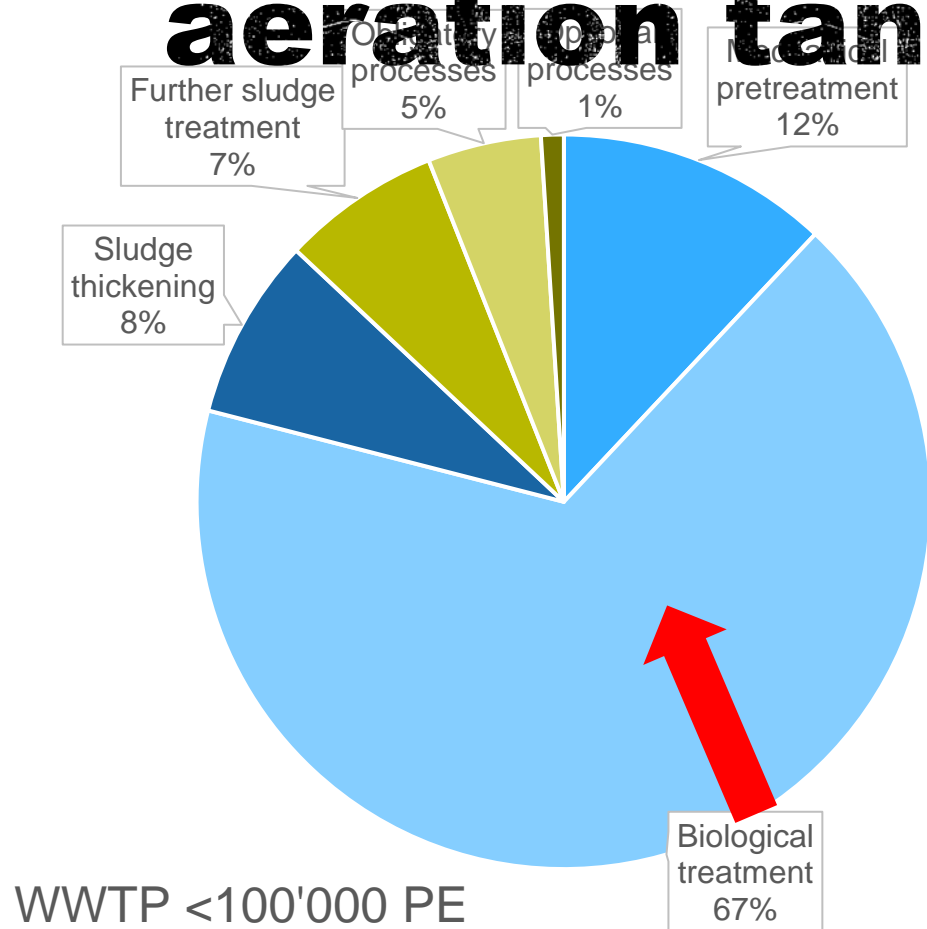
➤ There is no way to know which songs or features will be useful and thus popular when you first upload or develop them  
**The future is always uncertain! However, you can still shape it... if you have DATA.**

An aerial photograph of a vast, rugged mountain range. The peaks are covered in patches of snow and ice, contrasting with the dark, rocky slopes. The mountains recede into the distance, creating a sense of depth. A semi-transparent white rectangular box is positioned in the lower-left quadrant of the image, containing the main title text.

# **What shall be improved in WWTPs today?**

What if underestimating sturdy sensor inputs actually prevented you from saving big on energy? -  
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# >60% of a plant's energy is used to maintain bacterial activity in aeration tanks



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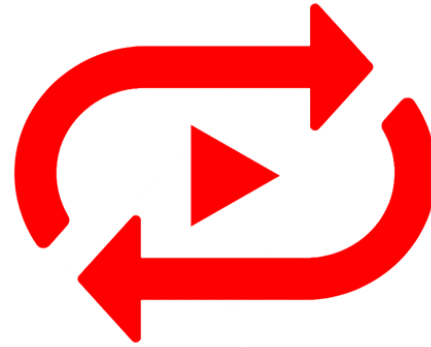


# >60% of a plant's energy is used to maintain bacterial activity in aeration tanks

- Operations are a combination of:



Throttle



Brake

If mixed liquor suspended solids (MLSS) exceed the intended threshold:

- Operators turn up the aeration (Turbo Mode!)
- MLSS go down, but might end up... too low!

... When MLSS end up to low

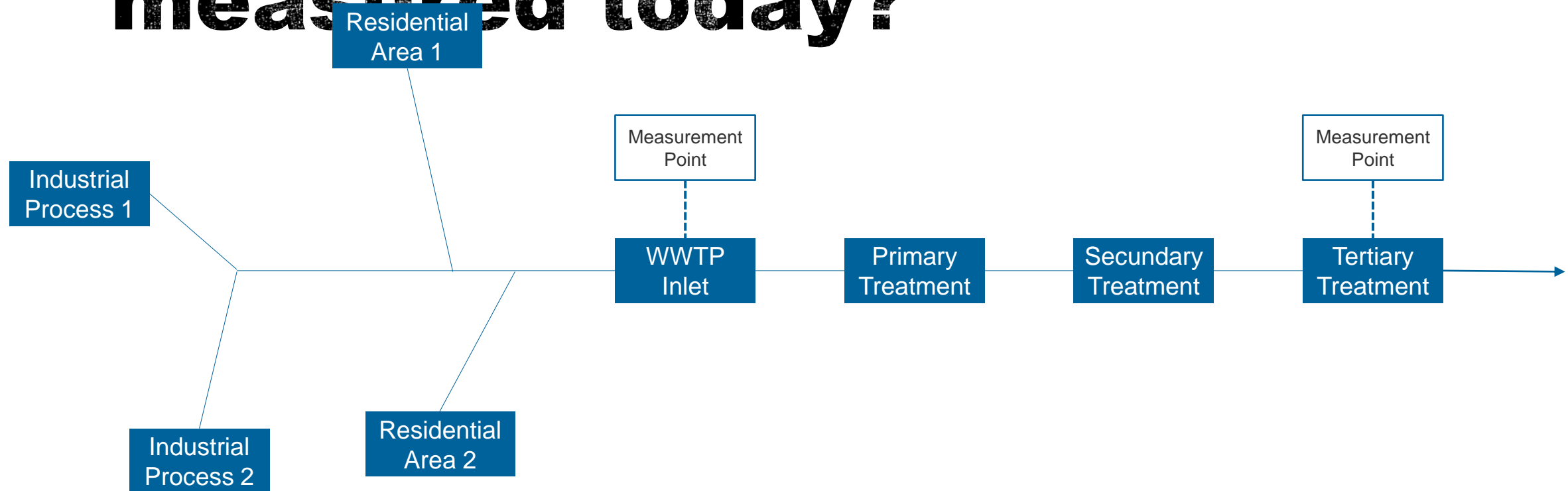
- Operators turn down the aeration
- MLSS go up, but might end up... too high!

But what is the root cause of the MLSS fluctuations?

→ **Organic Loads**

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# How are organic loads measured today?



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# Do we monitor our plants accurately?

- We take "process pictures"
  - At plant Inlet and Outlet
  - At daily or hourly interval
- Studies show that WWTP operators detect changes in water quality once a month, while data proves that those changes happen 3-4 times/week
- So we stay with our "best possible proxy," monitoring the process and act with throttle and brake.

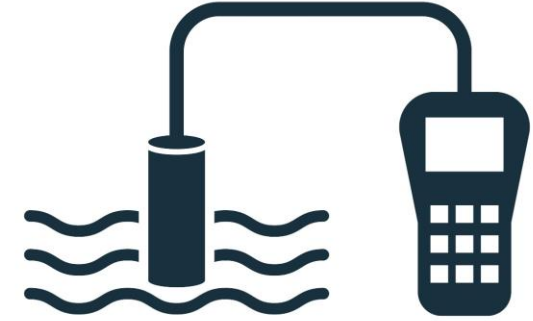
**Is there a better way?**



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# Let's add sensors?

- To better monitor the organic loads, we could add sensors in the plant (and in the network)
  - How many do we need? 10? 100? 1000?
  - How much would it cost?
  - How accurate is the measure? Does it drift over time?
  - What if it turns out we don't monitor the right parameters?
  - What does this involve in terms of maintenance?
  - What about parameters which are harder to measure in line?

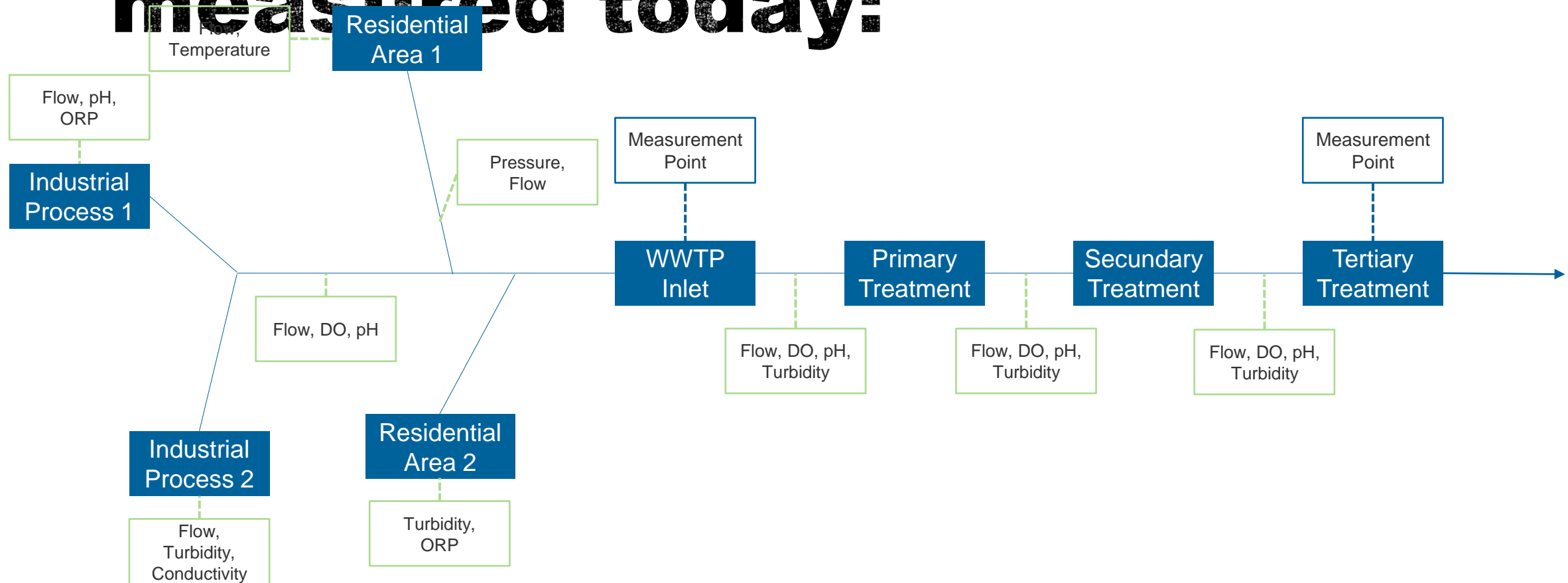


**WATER QUALITY SENSOR**

**Still, is there a better way?**



# Many things are already measured today:

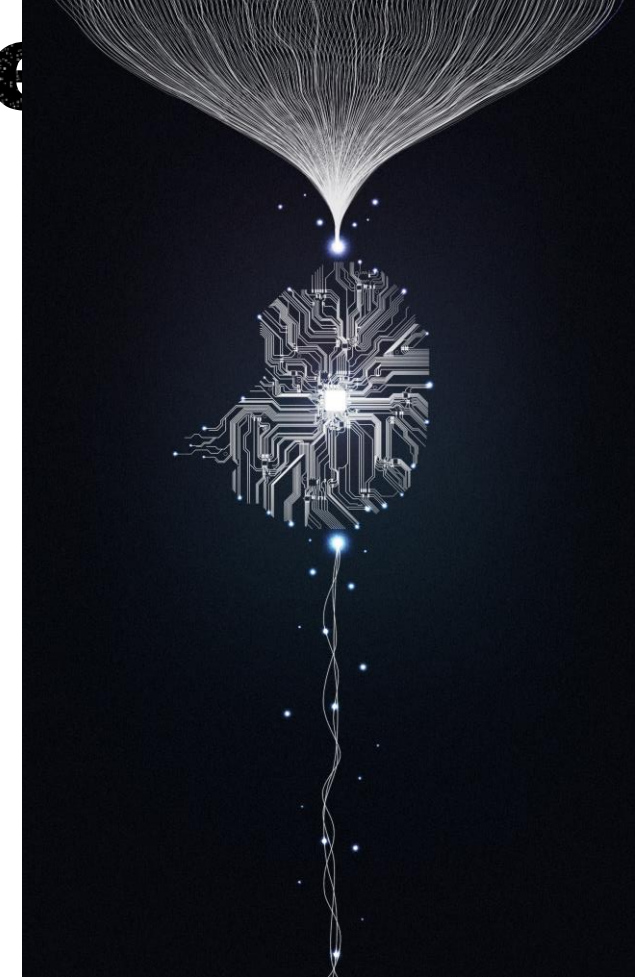


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**+ Can we make better  
use of what we  
already have?**

# Can we make better use of what we already have

- What if we could USE the existing:
  - T°,
  - Q,
  - pH,
  - DO,
  - ORP,
  - Turbidity,
  - Conductivity...
- to CALCULATE or even PREDICT further parameters?
  - COD
  - NH<sub>4</sub>
  - NO<sub>3</sub>...





# Towards "Soft Sensors"

- A 6-Steps approach:
  1. Pick an Industrial Site and gather "basic parameter" data over a relevant timeframe (the longer the better, minimum 8 weeks)
  2. Pre-process, clean and analyse the available data for Machine Learning (ML)
  3. Select the appropriate ML technique
  4. Develop (=train) the soft sensor on training data
  5. Validate (=test) the soft sensor based on test data
  6. Integrate the ML "soft sensor" into the plant's automation (operation advice)



# Step 1: Data Acquisition

- Study over 2 industrial parks in China within a "parent project"
  - *We showed possible stream synergies to reduce the use of chemicals within the WWTP (37% reduction on the pilot plant)*
- Data is acquired from the existing sensor base.
  - Leveraging existing hardware
  - Data is derived from the same routes that also feed into the Plant PLC and SCADA
  - For safety reasons, we fed our "on premise cloud platform" with a 24h delay with realtime
  - Lab Analysis (COD, NH4, NO3) are fed into the same platform

Dashboard > Prioritize Factories > Proposed Treatment Plan > Treatment Results

### Treatment Results

Search:  Export report Filter

Past Treatments

Treatment ID	Date	Mixed pH	Volume, L	Pool	Costs saved, Yuan	Time
<a href="#">038820JSMKD</a>	11.05.2020	8.6	5000	1	1053.54	16.12
<a href="#">038820JSMKD</a>	11.05.2020	10	5500	2	935.34	16.10
<a href="#">038820JSMKD</a>	11.05.2020	10.1	5700	2	1135.34	16.00

Current Treatment (Starting at 16:05)

Dashboard > Prioritize Factories > Proposed Treatment Plan

### Proposed treatment plan

Search:  Export report Filter Treat wastewater now

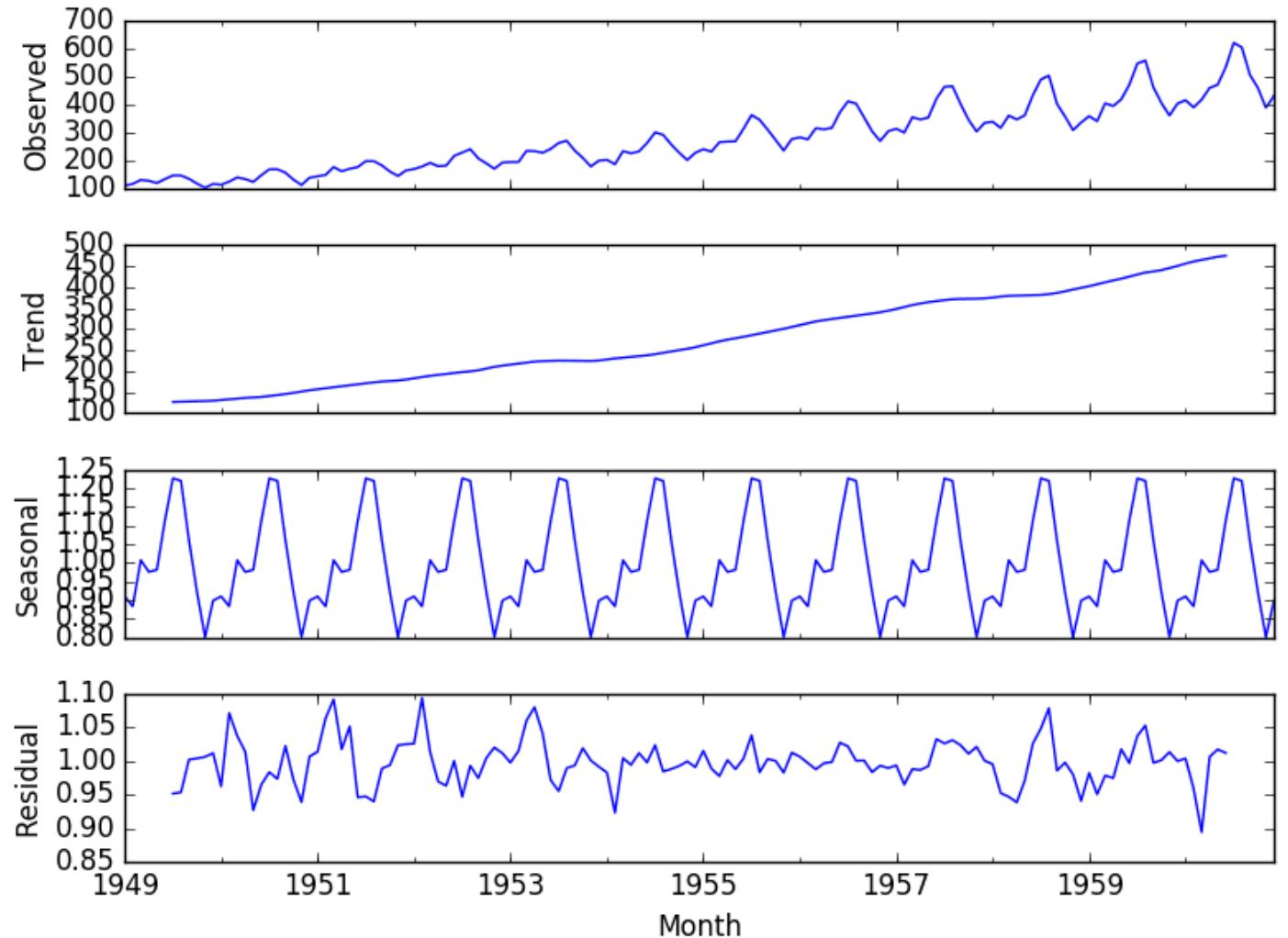
Factories

Prioritized	Factory Streams	pH	Volume, L	Mixed pH	Mixed Volume, L	Cost Saved, Yuan
	Pfizer	11.0	1000			
	Roche	1.0	2750	1.364	4530	8836.04
	BASF Stream 1	13.0	780			
	Bayer	2.0	2000			
	BASF Stream 2	4.0	1780	2.273	3780	0.13

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# Step 2: Pre-processing Data

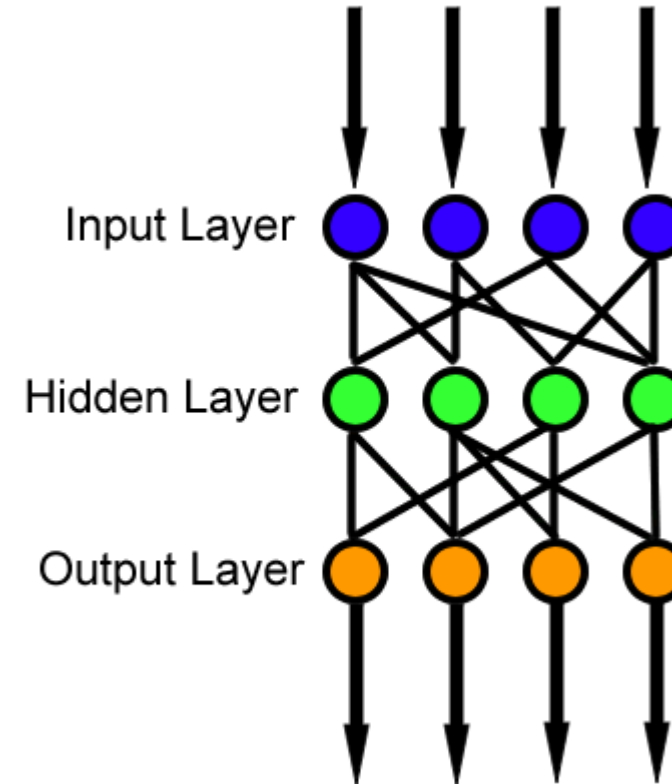
- Data is pre-processed and cleaned
- A first analysis cuts each target parameter (COD, NH<sub>4</sub>, NO<sub>3</sub>) into three sub-sets of data:
  - Trend
  - Seasonality
  - Residual





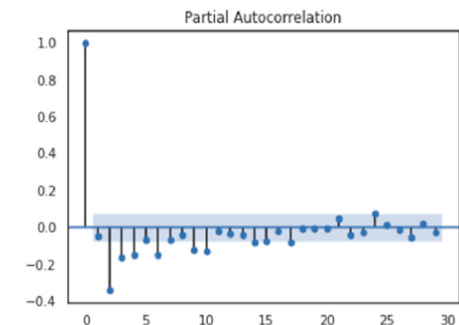
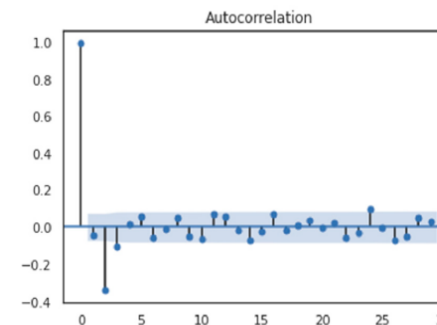
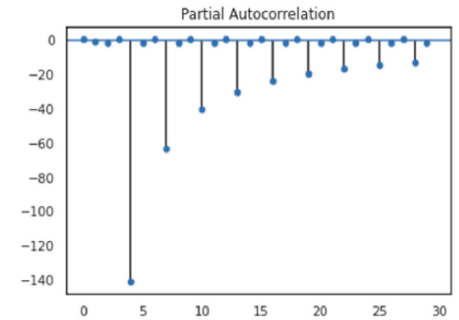
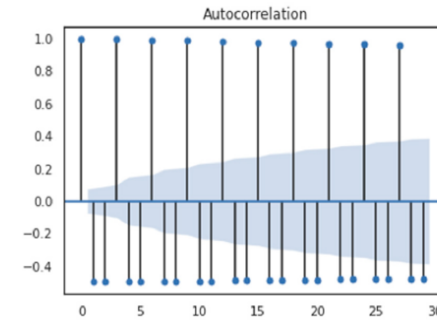
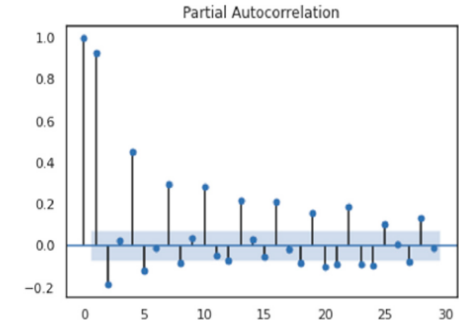
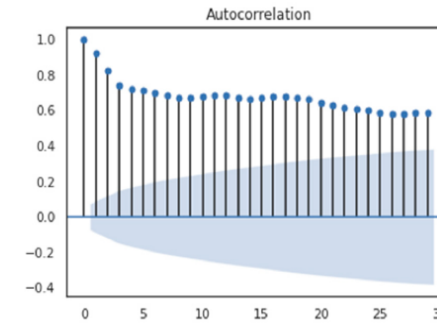
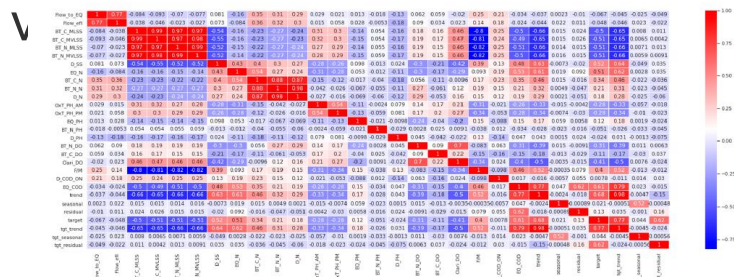
# Step 3: Select the appropriate ML Techniques

- We extracted a short list of suitable techniques from scientific literature review (especially Haimi et al, 2012)
  - Time Delay Neural Networks (TDNN)
  - Multiple Linear Regression (MLR)
  - Self-Organizing Map (SOM)
  - Expectation-Maximization Principal Component Analysis (EMPCA)
  - **Feedforward Neural Network (FFNN)**
    - Inputs are fed to the Outputs via a series of weights (Hidden Layer)



# Step 4: Develop (train) the soft sensor

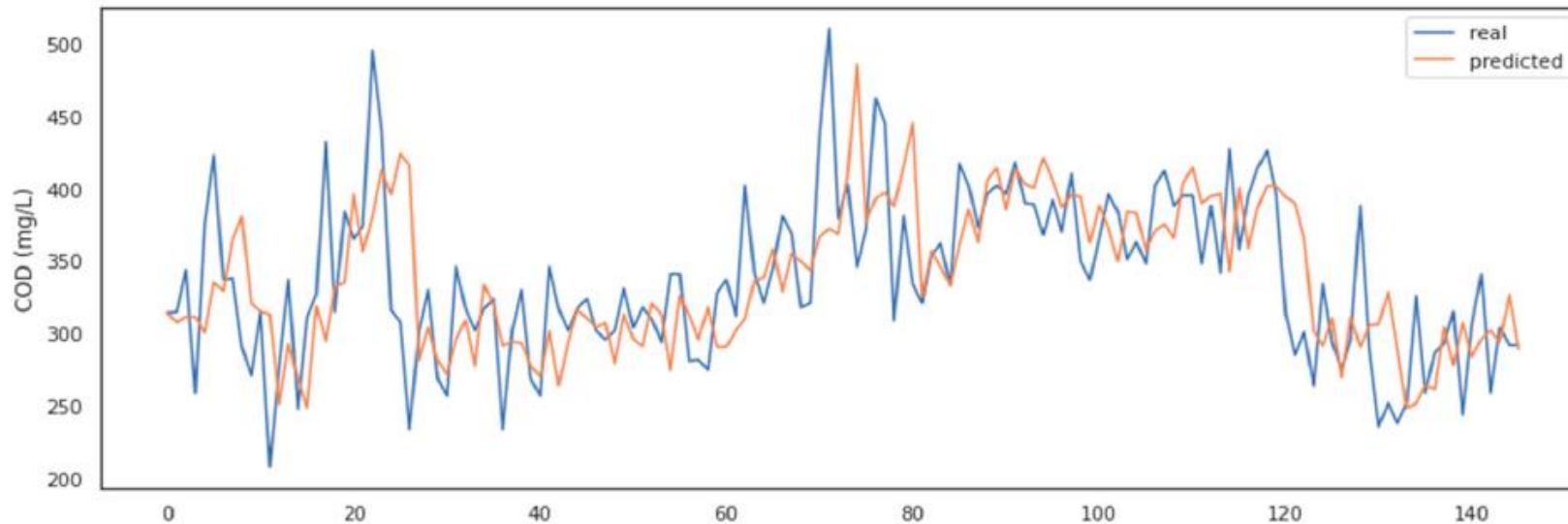
- An auto-correlation is conducted over the three components of the target parameter
  - Trend (top)
  - Seasonal (middle)
  - Residual
- Not all simple parameters (Flow, DO, pH...) have a relevant influence on the intended output



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# Step 5: Validate (test) the soft sensor

- Predicted values are validated with a comparison to sample output data
  - A "Delta Rule" learning algorithm further trains the "Soft Sensor" by calculating errors between calculated and output data, and adjusting the weight
- Over our 2-months pilots on the 2 industrial parks, we had respectively 5 and 7% error between calculated and measured
  - This error is the "Delta Rule"

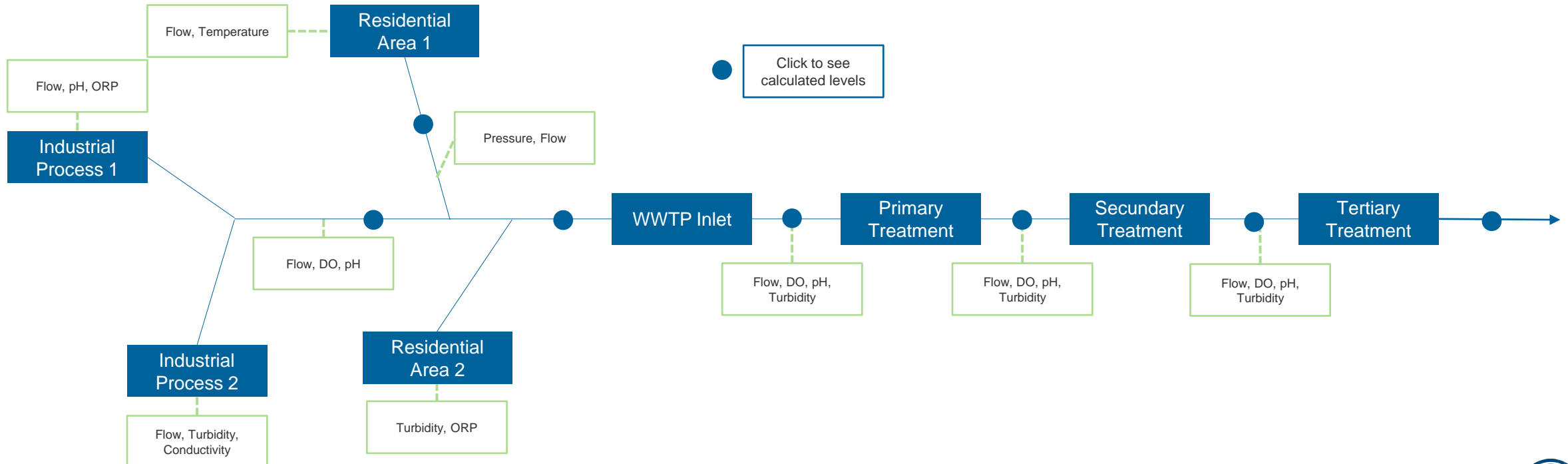




# Step 6: Integrate the ML "soft sensor" into the plant's automation (operation advice)

Outside of IT's scope

- For the sake of the pilots, we integrated a "Soft Sensor" layer map in the on-premise cloud:



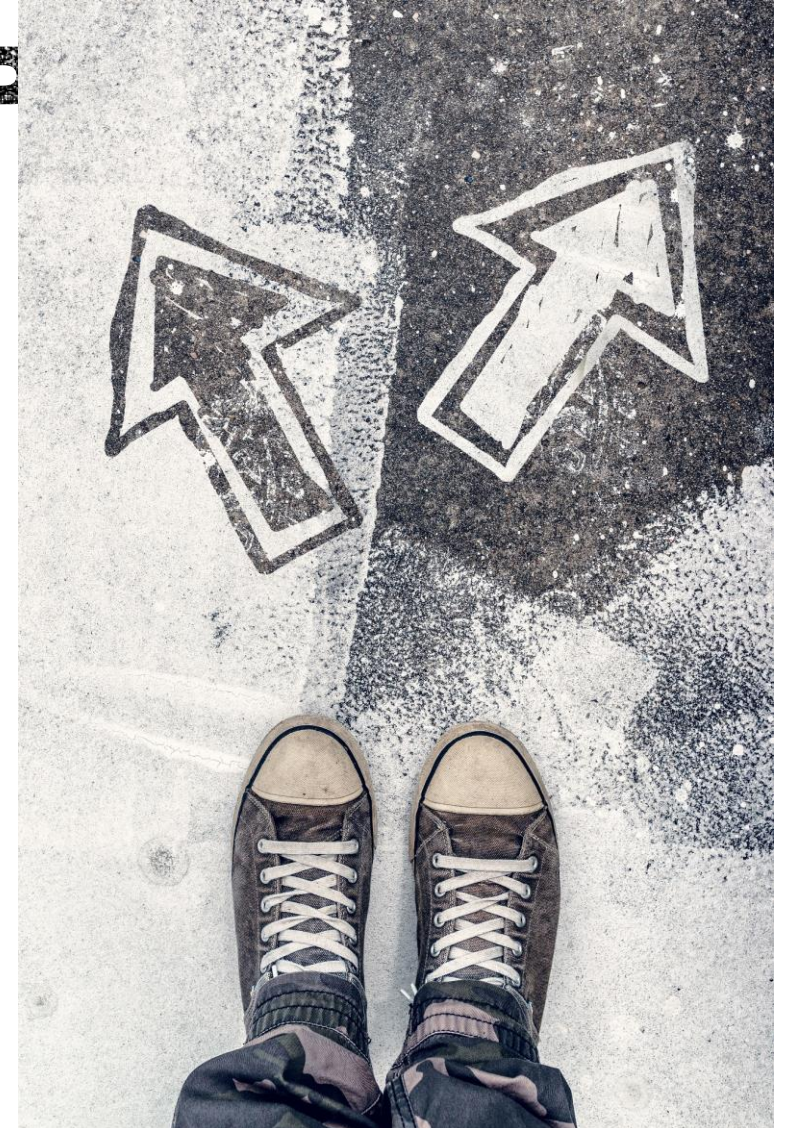
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# Results over the 2 P

- A further 22% reduction in Chemicals used onsite was achieved
- Over the testing period, energy costs were reduced
  - Further integration of the "Soft Sensors" will enable to "industrialize" the optimization
  - A larger set of data will enable to quantify the savings
- Literature results indicate:
  - **A potential for 40% savings on operating costs\***
  - Welcome side effects such as increasing of hydraulic/load capacity (up to 80%)\*

\*Bluekolding Case Study

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An aerial photograph of a rugged mountain range, likely the Alps, with significant snow cover on the peaks and ridges. The entire image is overlaid with a semi-transparent blue filter. A horizontal white bar is positioned across the middle of the image, containing the word "Outlook" in a bold, black, sans-serif font.

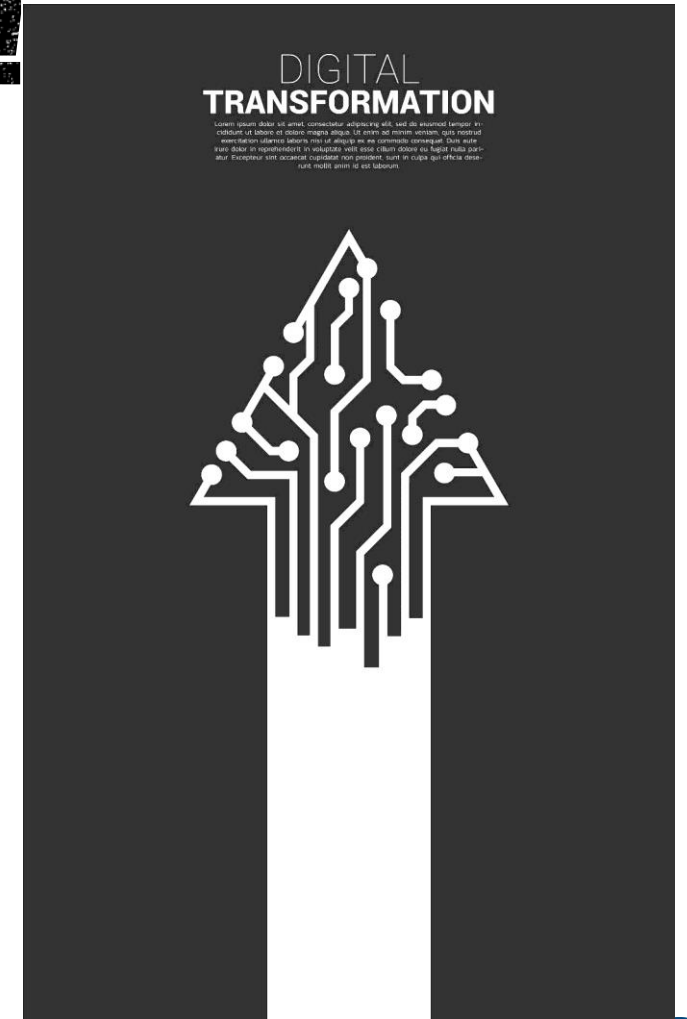
# Outlook



# Future might be complex, but built on simple bricks!

- Who knows which parameter will be decisive to accompany the road to "net positive energy" that WWTP will take over the next decade(s)?
  - Like Burbn, YouTube or Spotify, you have to invest in data today, to have the "building bricks" you'll need tomorrow
  - Simple process parameters (Flow, T°, pH, Conductivity...) are the bedrock of data you need to be even more efficient tomorrow
- We're watching our smartphones 150 times per day (8 times during this presentation?) and reacting to an SMS within 4 minutes.
  - **Wouldn't it be about time to implement this reactivity into our operation processes?**

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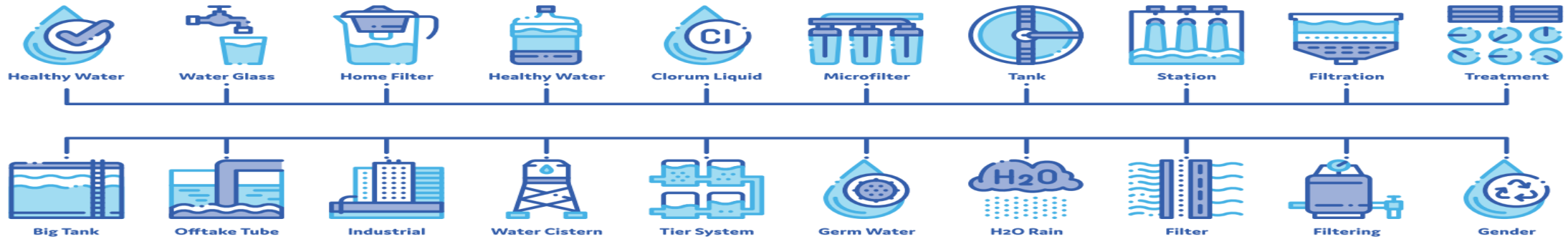
# Questions?

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# What if underestimating sturdy sensor inputs actually prevented you from saving big on ENERGY?



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## Q&A

Christine Yap  
Sales Engineer Water Treatment of  
Georg Fischer



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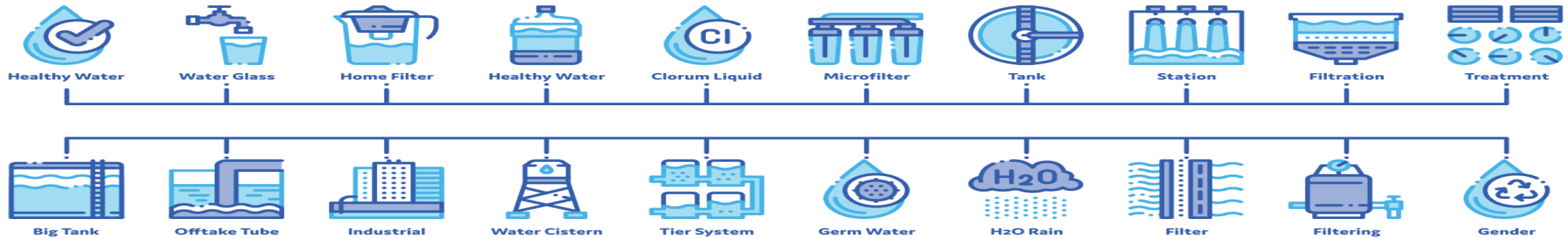




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## Upcoming

### Webinar with SBF :

Singapore Water-Waste-Food (WWF)  
Virtual Market Entry Programme

(22 April 2021, 2pm to 4pm)

### Webinar with Pioneer Environmental :

MVR Based Zero Liquid Discharge and Decentralized  
Sewage Treatment Plant

(5 May 2021, 10am to 11am)

### Webinar with NTUC USME :

Digital Reboot Programme

(17 May 2021, 3pm to 4pm)

### Webinar with the Danish Export Association:

Water resource recovery – A dialogue between  
Denmark and Singapore on key innovations and  
opportunities ahead in the water sector

(11 May 2021, 3pm to 430pm)

### Webinar with SgWX :

Water Utilities Series - MWA, Thailand

(21 May 2021, 3pm to 4pm)

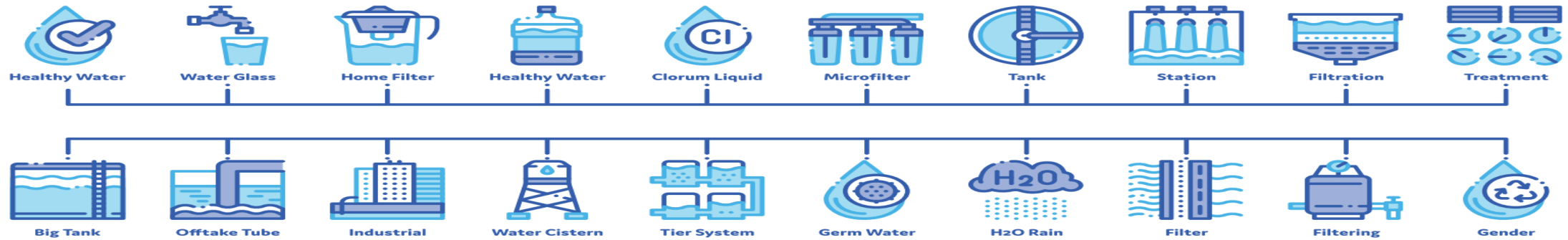
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**For further queries on the event, please contact :**



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