

Thermal remediation of a CVOC site

- a data driven thermal project

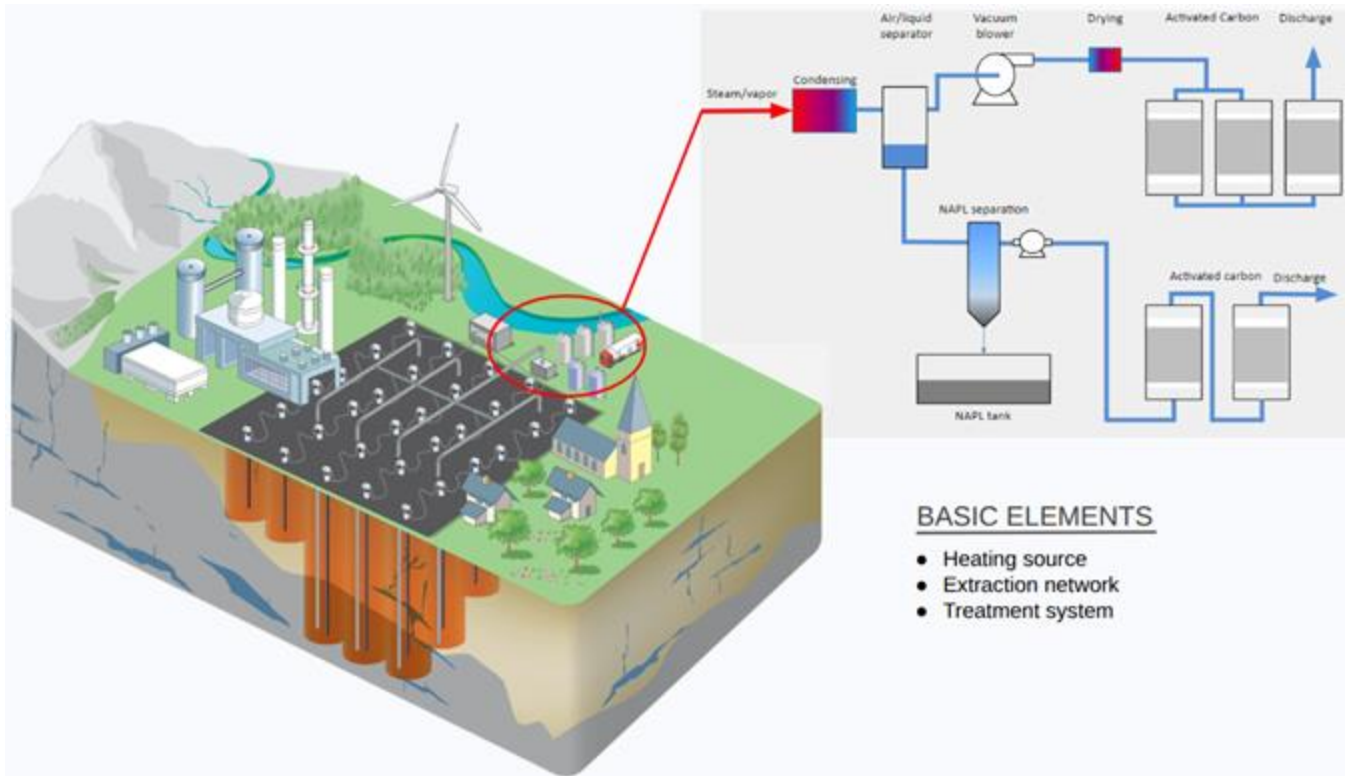
Hazardous Waste Europe



Agenda

- Site presentation and thermal design
- Data handling - data comparison (model vs. actual)
- Forecasting and analysis tool
- Wrap up

Basics of Thermal



Important design parameters

- Contaminants (min, max, average)
- Clean up goals
- Geology (porosity, saturation)
- Hydrogeology (water movement)
- Boundary conditions
- Time (**Power only available from May to October**)

Site: Hässleholm, Sweden

Geometry

Area: 430 m², Depth 10 m, Volume 4.300 m³

Geology

0 - 6/8 m	Morainic deposits
6/8 - 10 m	Granite

6/8 - 10 m Granite

Groundwater table 2-3 mbgs

Contaminants

Primarily PCE, max conc. 21.400 ug/l

Remedial goals

All temp points > 100 °C for 10 consecutive days

Asymptotic removal < 300 g/day for at least 3 days
Remedial goals 1 000 µg/l Sum (PCE+TCE+DCE+VC)



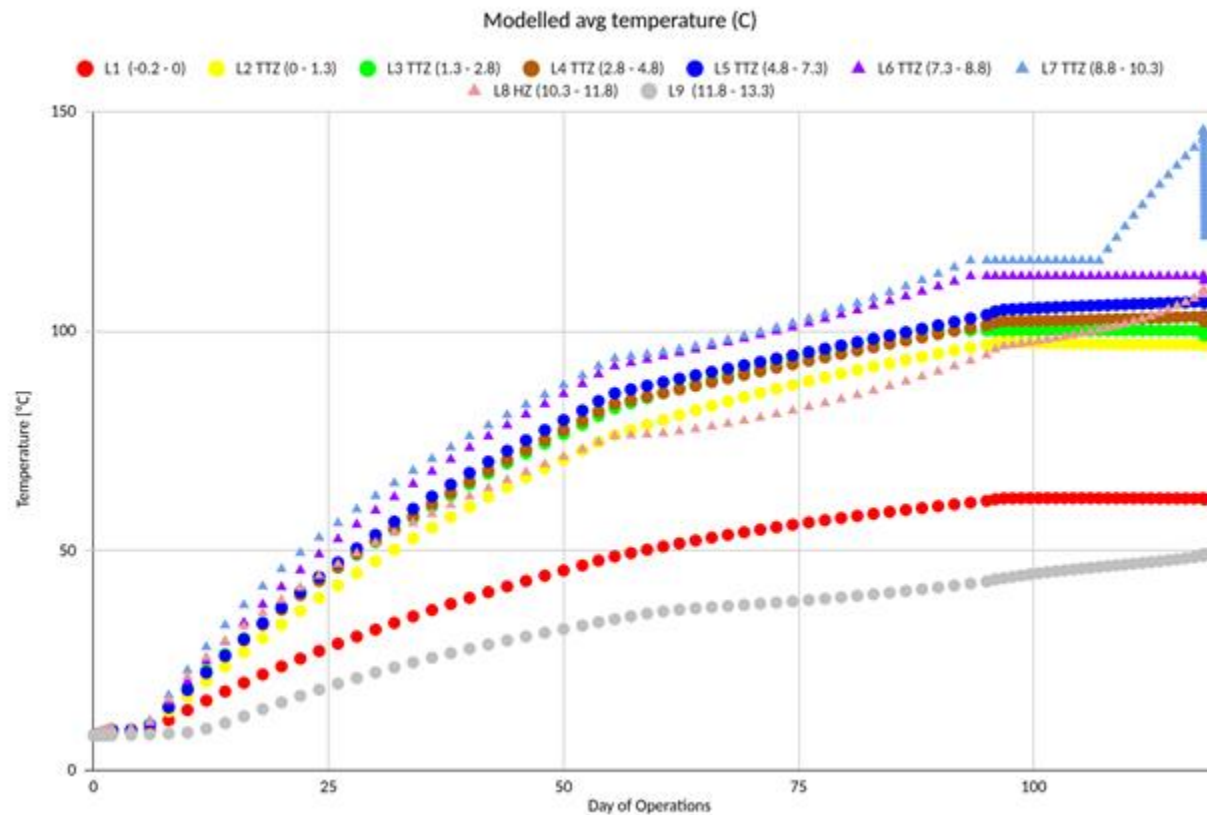
Design subsurface

Numerical model

- Layers form the conceptual model
- Set up layers
 - Porosity
 - Hydraulic conductivity & gradient
 - Power input (boost/non boost)
 - Stem extraction
 - Potential pumping
 - Days of heating
 - Need for vapor cover

		Thickness	Depth bottom layer		GW velocity	TTZ	Heater	Heater input	Hydraulic conductivity	Porosity	Saturation
		(m)	mbgs		(m/day)			kW/m	k (m/s)		
0.0	Layer 1 - Vapor Cap	0.2			-			0.2			
1.3	Layer 2 - Fyllning/makadam - TTZ	1.3	1.3		0.000			0.64	5.0E-06	0.35	0.80
2.8	Layer 3 - Sandmoræn unsat - TTZ	1.5	2.8		0.000			0.84	5.0E-06	0.35	0.90
4.8	Layer 4 - Sandmoræn sat-1 TTZ	2.0	4.8		0.009			0.84	5.0E-06	0.35	1.00
7.3	Layer 5 - Sandmoræn sat-2 TTZ	2.5	7.3		0.009			0.84	5.0E-06	0.35	1.00
8.8	Layer 6 - Berg 1 - TTZ	1.5	8.8		0.003			0.84	2.0E-06	0.35	1.00
10.3	Layer 7 - Berg 2 - TTZ	1.5	10.3		0.003			1.032	2.0E-06	0.12	1.00
11.8	Layer 8 - Berg 3 - HZ	1.5	11.8		0.003			1.2	2.0E-06	0.12	1.00
13.3	Layer 9 - Bottom	1.5	13.3		0.003			0	2.0E-06	0.12	1.00

Design subsurface



Design - Well layout

Heater well layout (54)

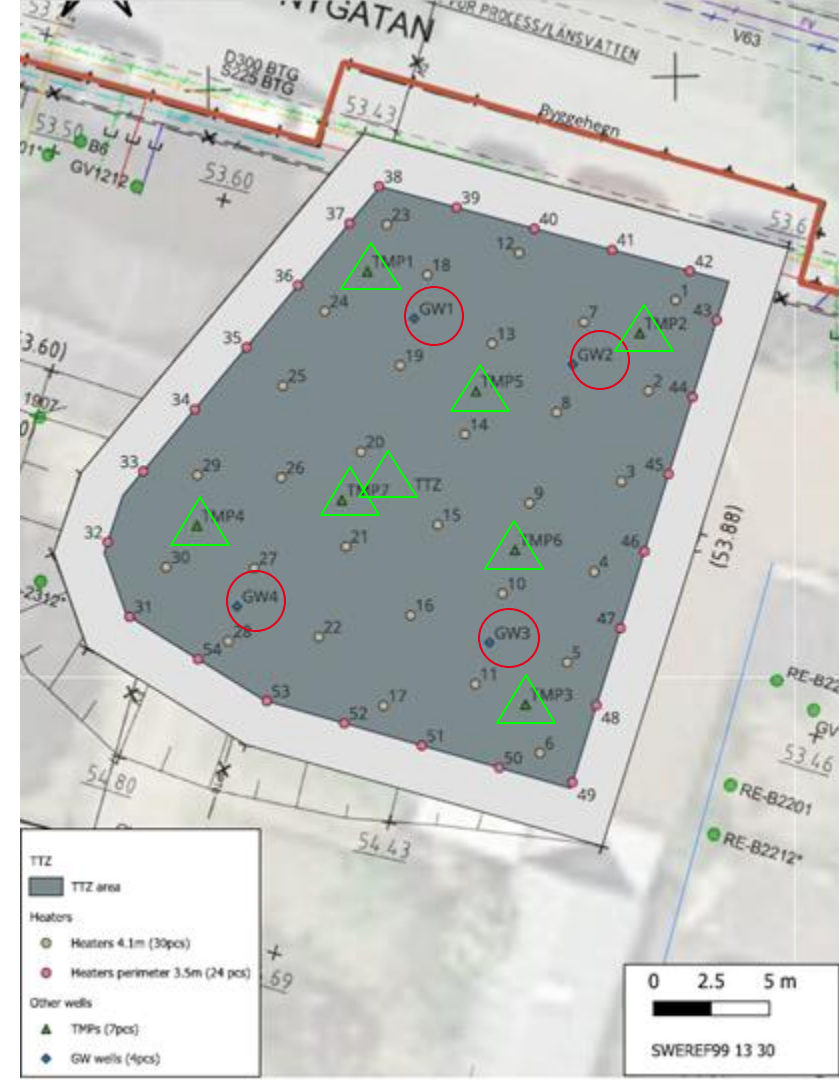
- Perimeters - closer spacing due to heat loss

Groundwater monitoring wells ④

- Two screens per well 3 - 5 & 7 - 9 mbgs

Temperature monitoring wells △ 8 (80 points)

- Temperature monitoring points in centroids





Site offices

Cooling water

Activated carbon

Vacuum & cooling

Backup generator

Transformer

Vapor /liquid

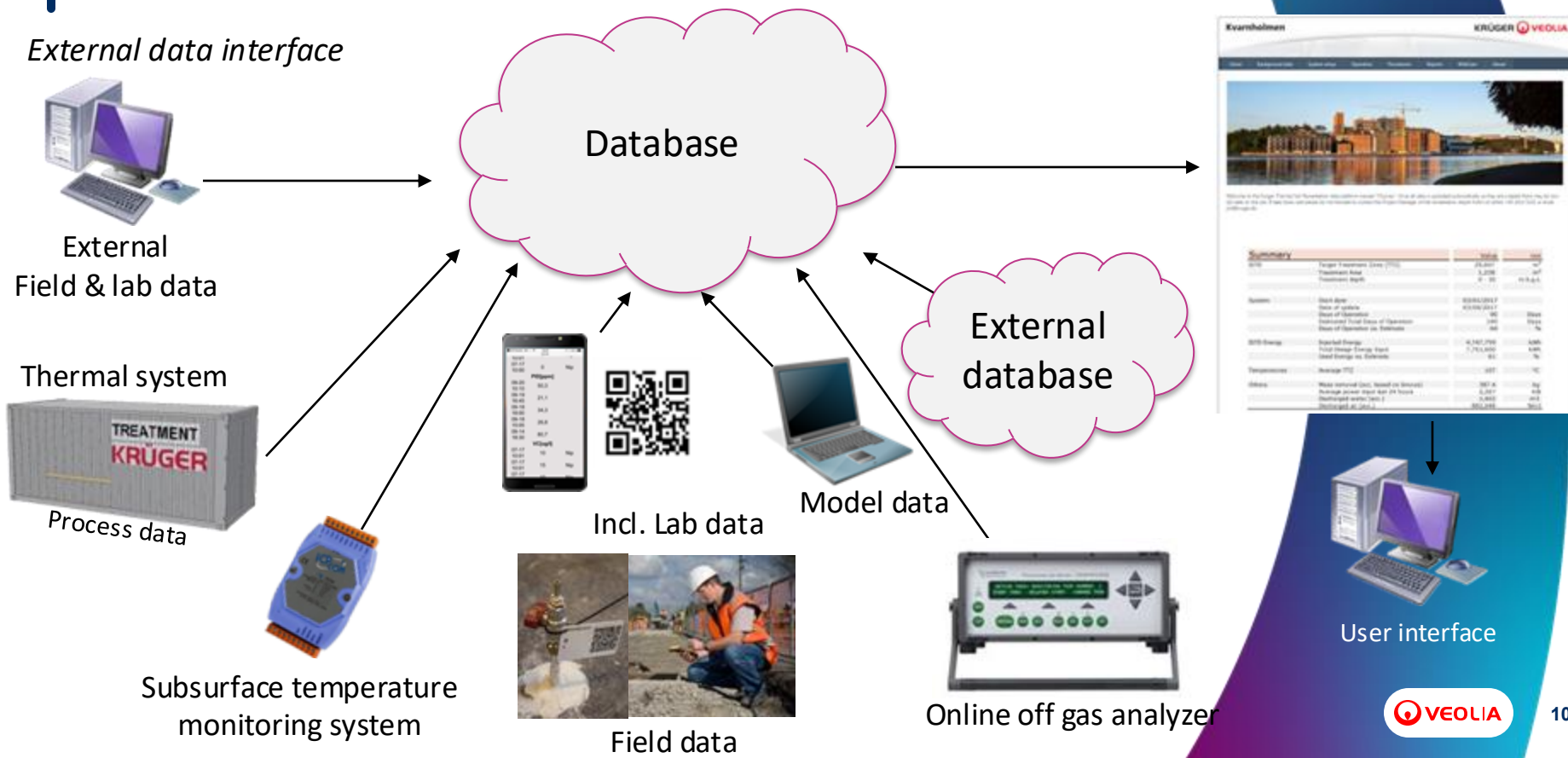
Power Unit

Liquid filtration

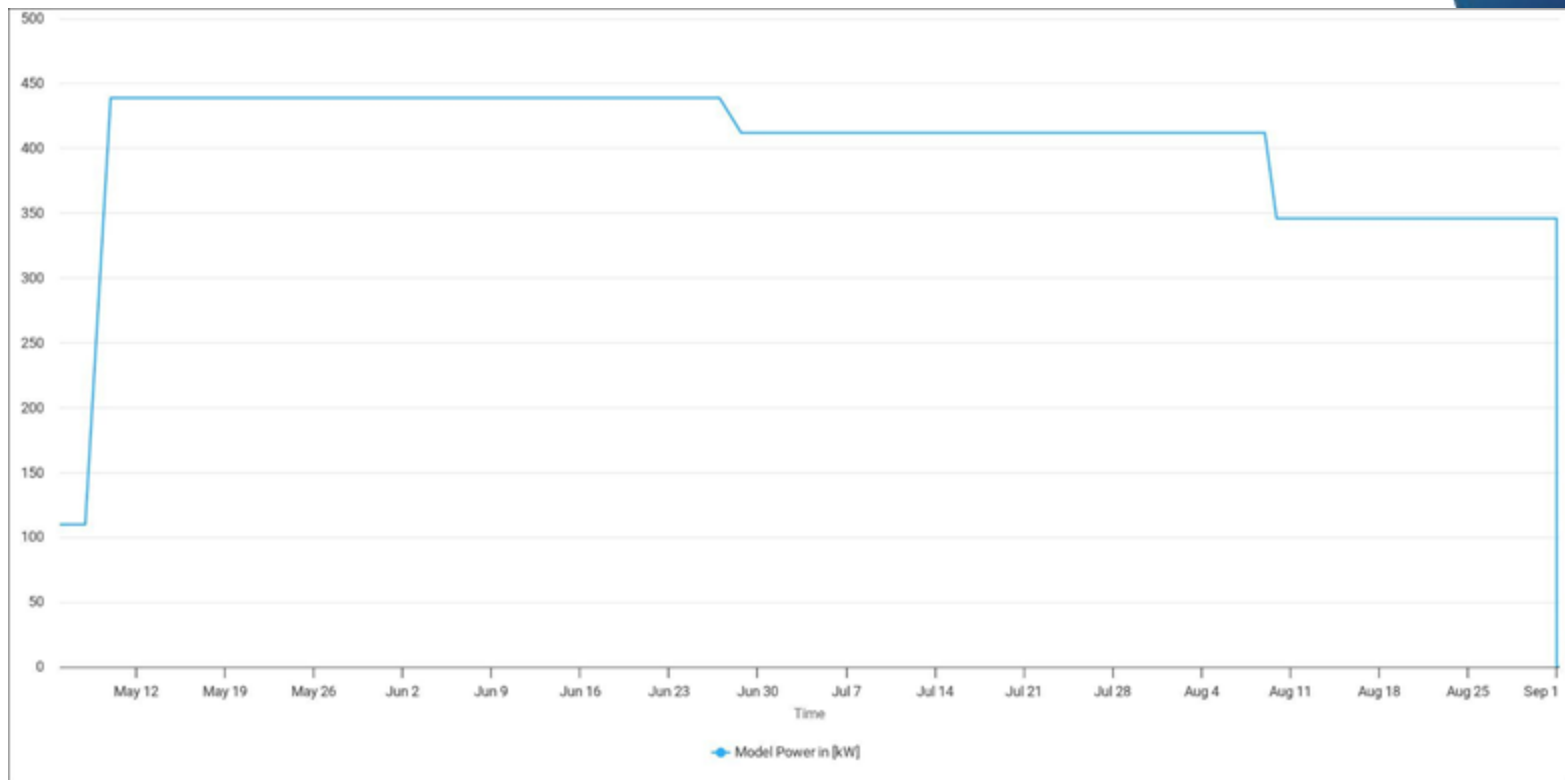
TTZ

Data handling

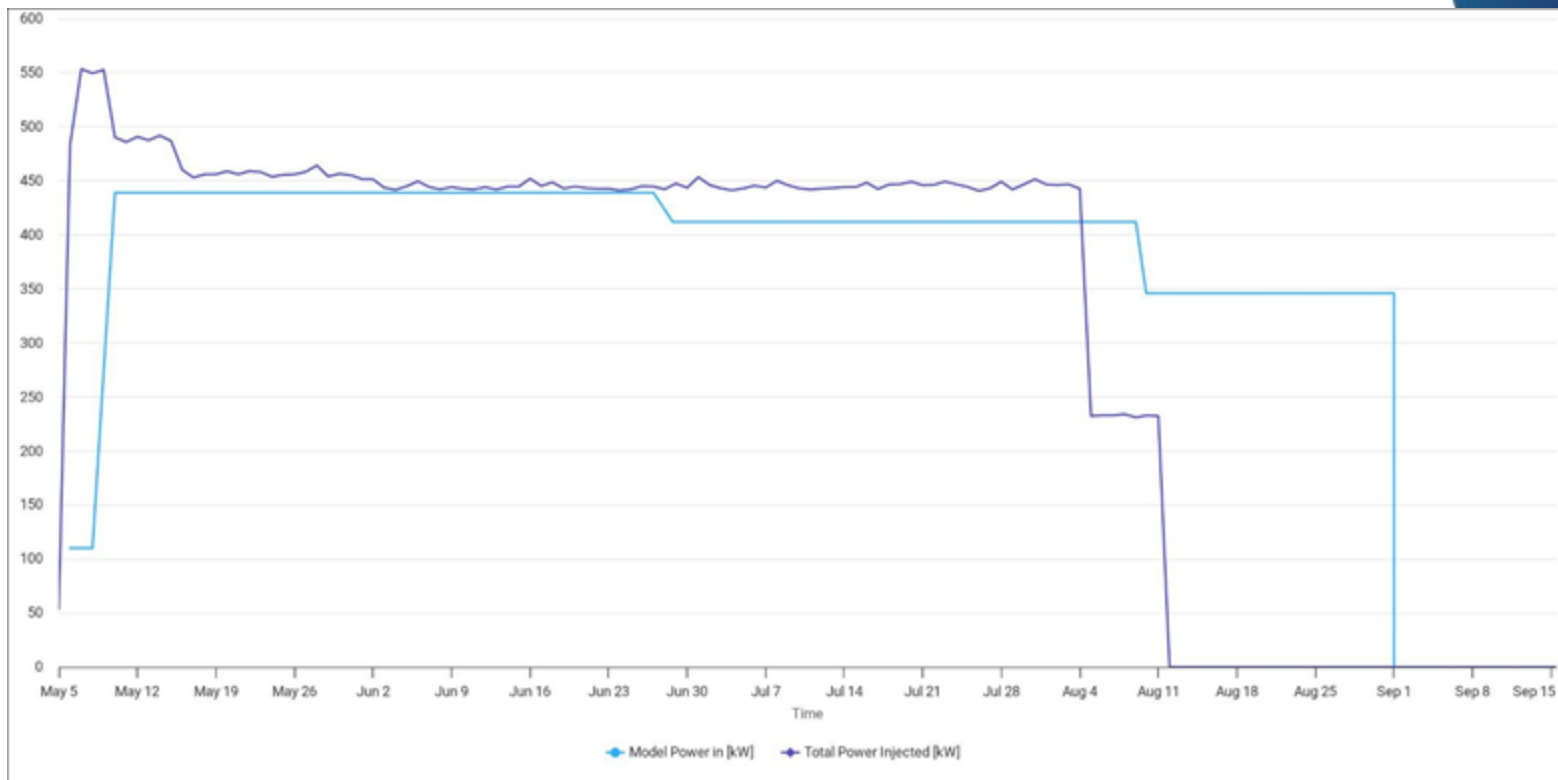
Web



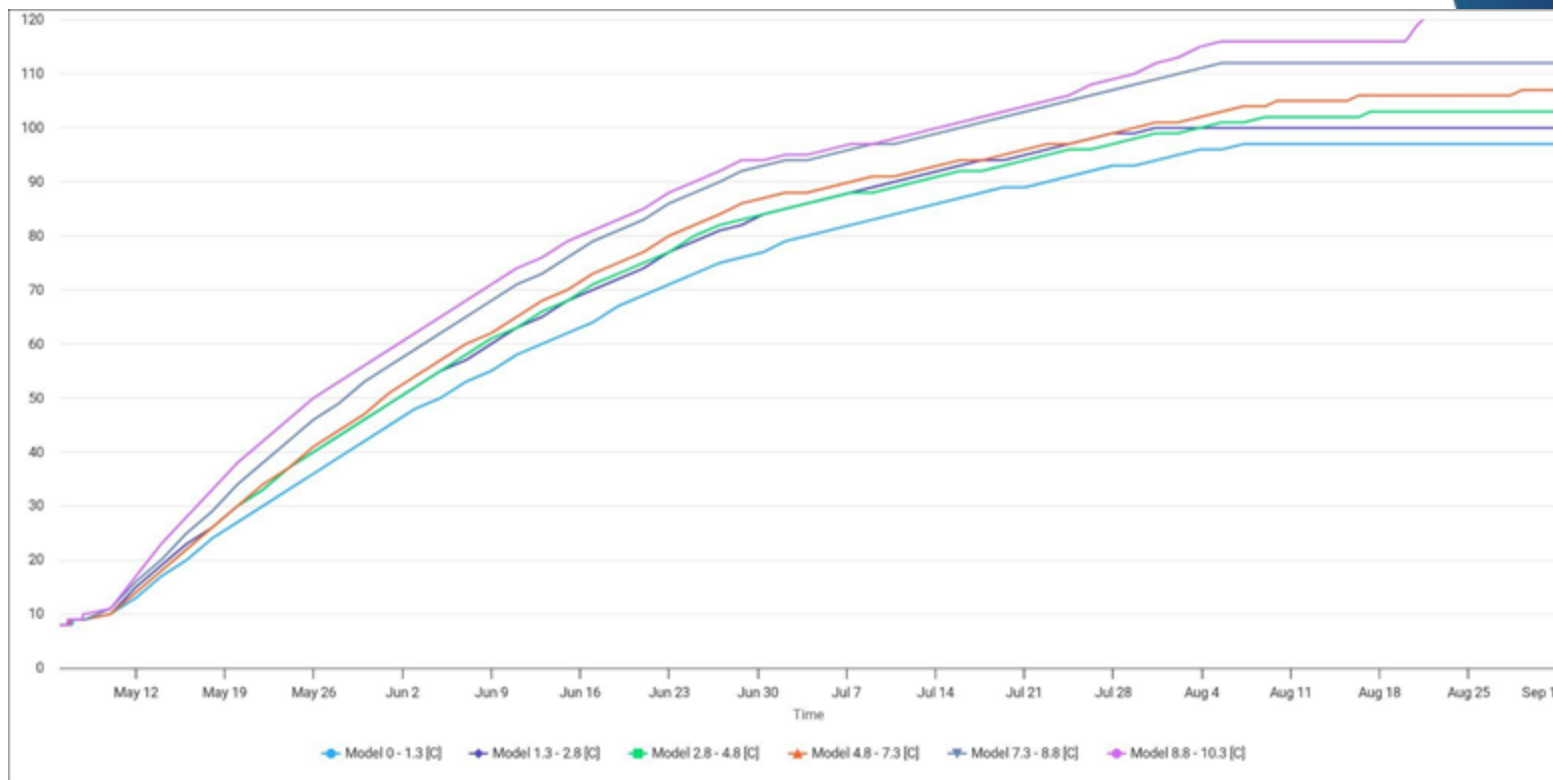
Power input - model



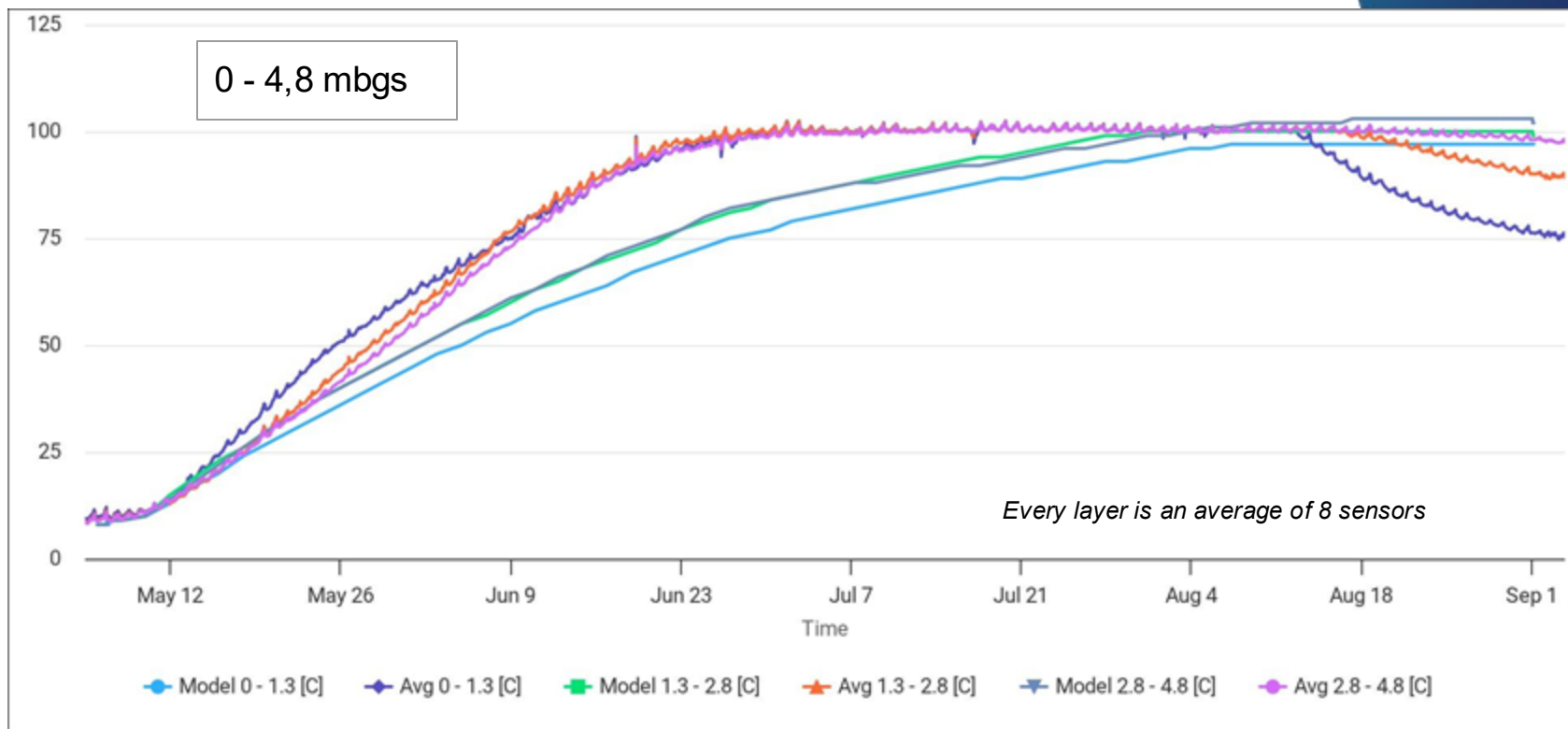
Power input - model vs. actual



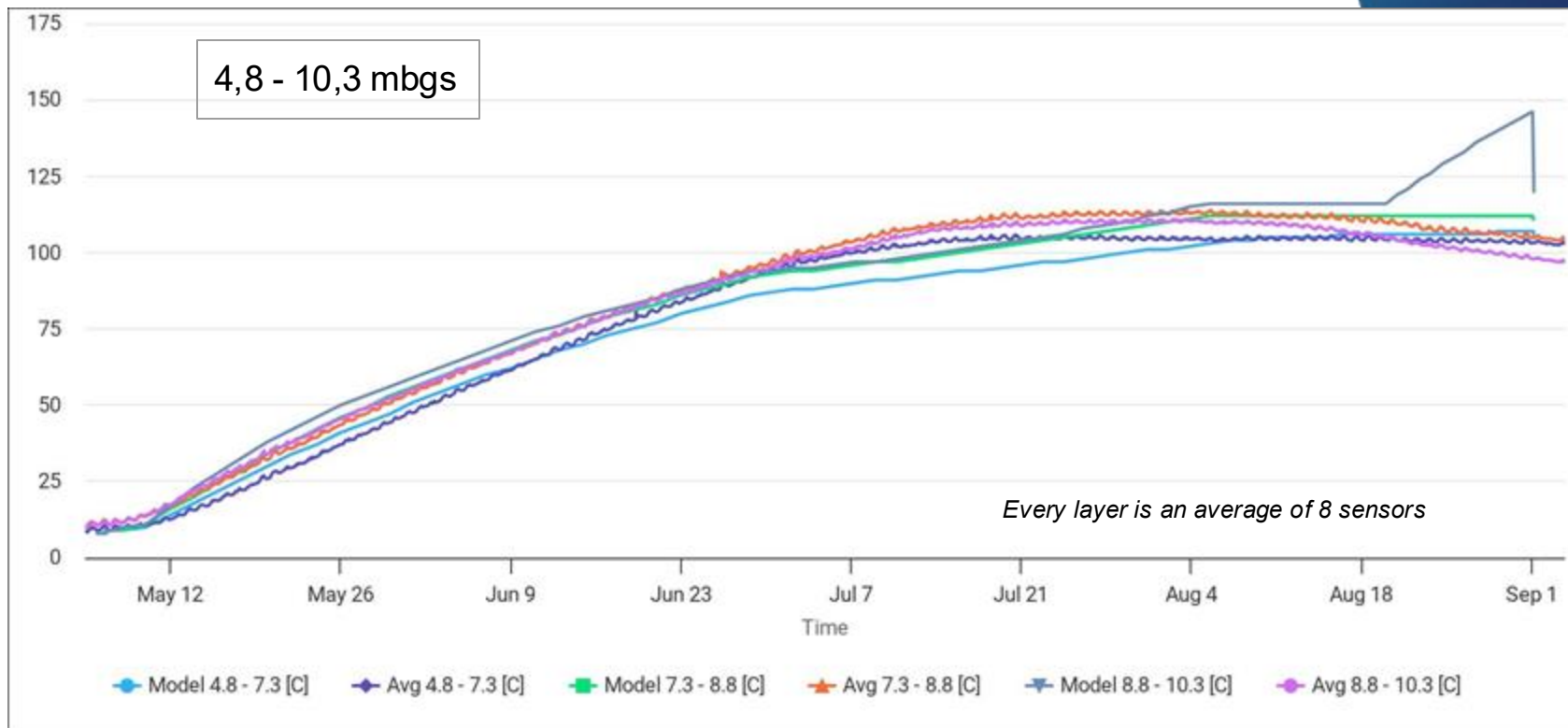
Layer temperatures - model



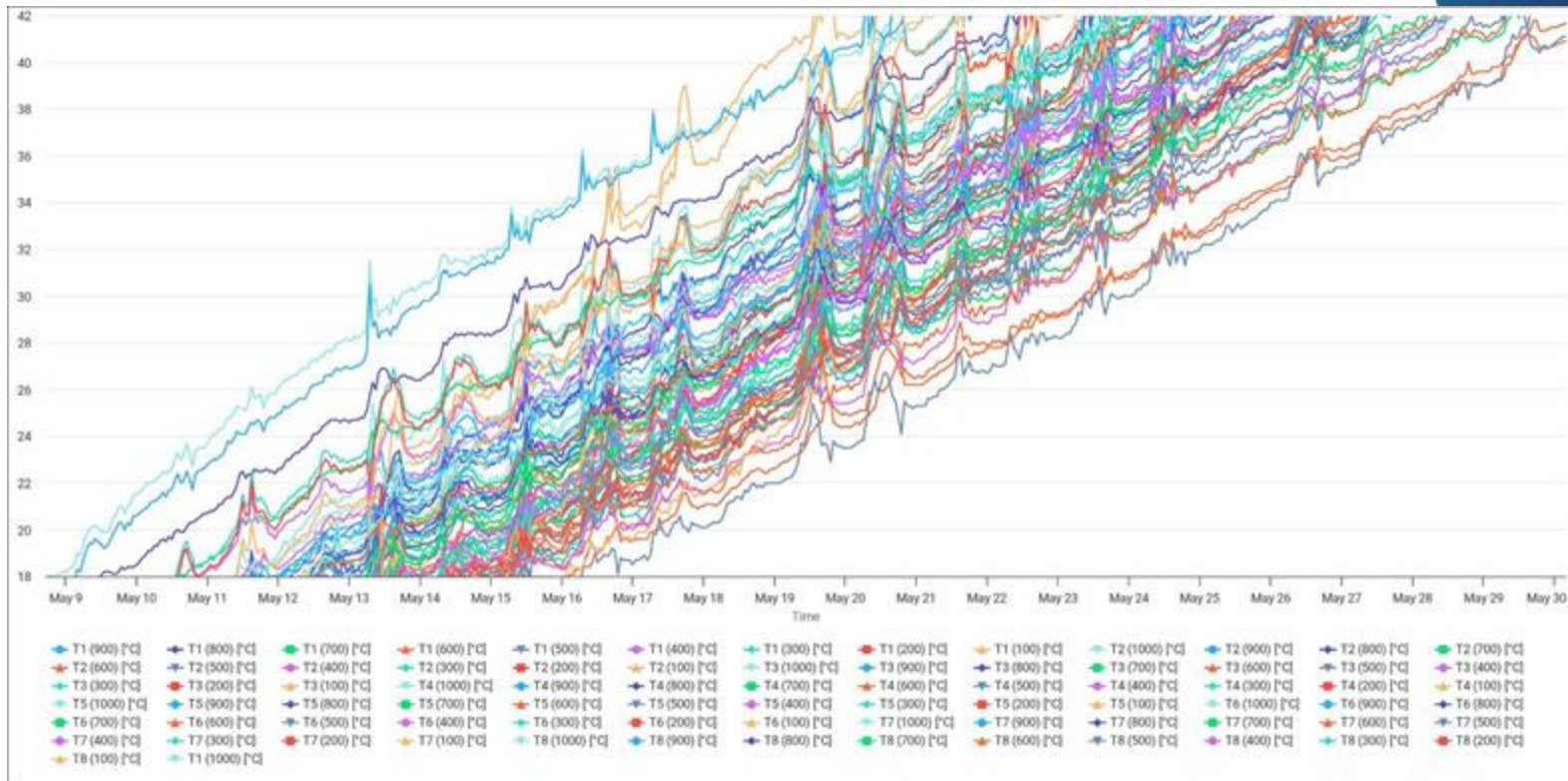
Layer temperatures - model vs. actual



Layer temperatures - model vs. actual



Forecasting and analysis tools?



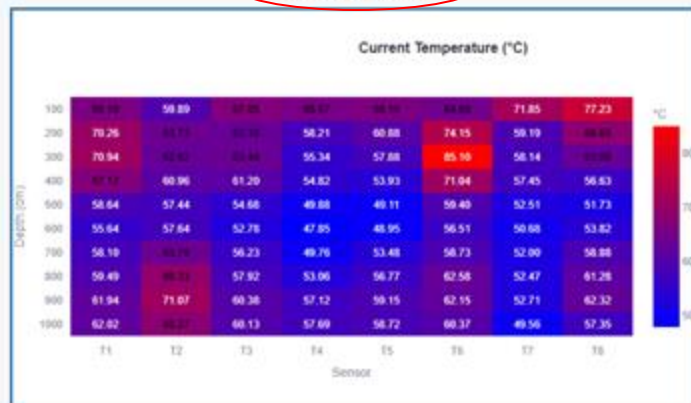
Forecasting and analysis tools?

- Purpose
 - Current Temperature
 - Rate of Change ($^{\circ}\text{C}/\text{day}$)
 - Projected Schedule Status
 - Warning Summary
- Input
 - X,Y - Tmp points and heater wells
 - Power input heater wells

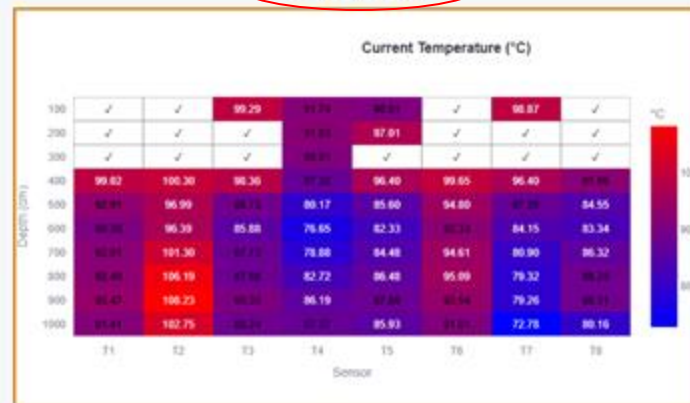
Current temperature

Current Temperature

03 June 2025



24 June 2025



Project timeline



Rate of Change

Rate of Change

03 June 2025



24 June 2025



Project timeline



Projected Schedule Status

Projected Schedule Status

03 June 2025



24 June 2025



Project timeline



Warnings

Warning Summary

03 June 2025

Warning summary (all sensors / depths)

No rolling-window anomalies detected for the selected period.

24 June 2025

Warning summary (all sensors / depths)

Sensor	Slow/Inefficient	Behind	Low Relative Temperature	Other
T4			600	
T7		1000	1000	

Project timeline

03 Jun 2025

24 Jun 2025

Estimated end (4 months)
05 Sep 2025

Treatment start
05 May 2025

Treatment end
11 Aug 2025

May

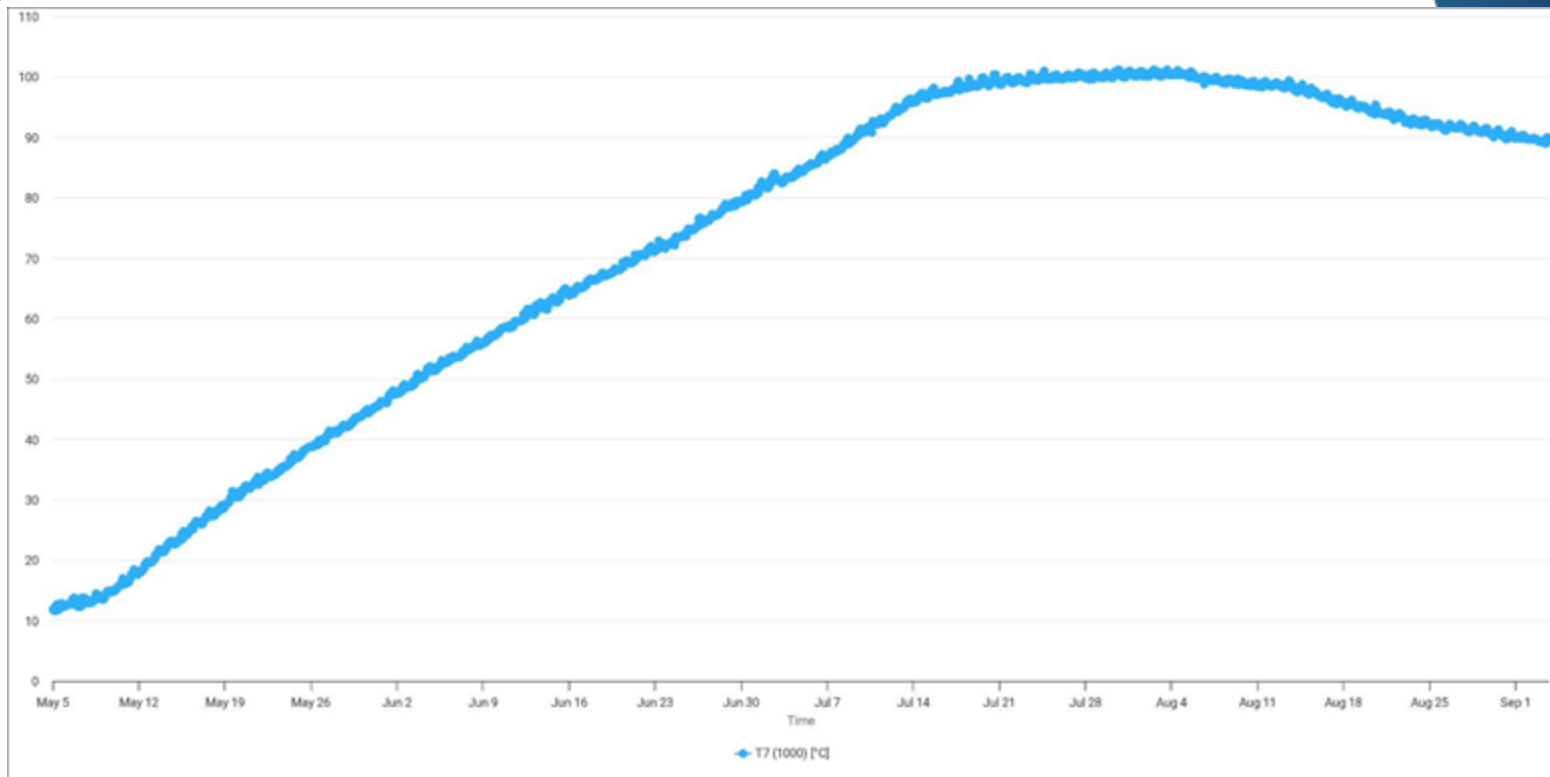
Jun

Jul

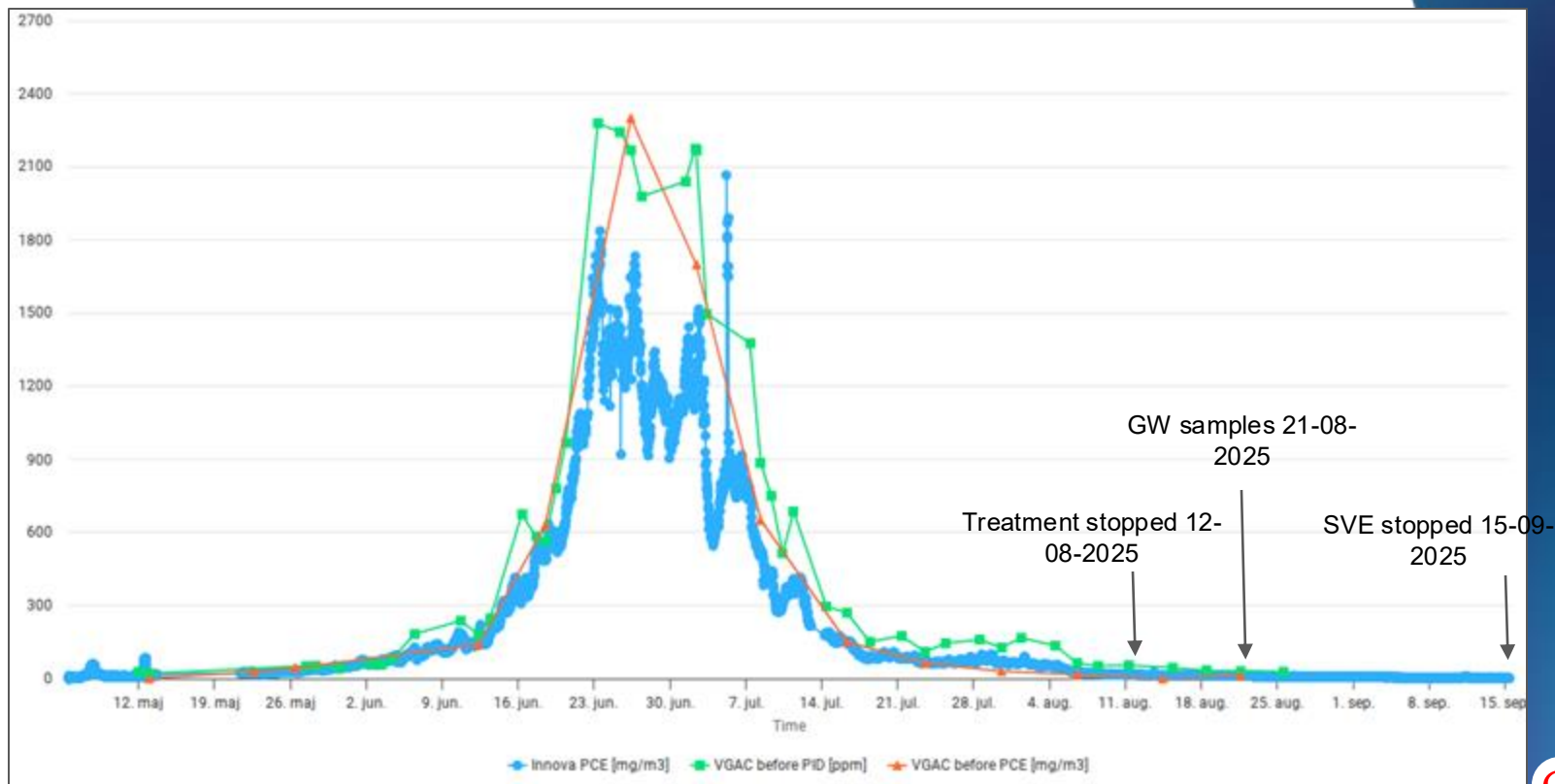
Aug

Sep

T7 - 10 mbgs - actual temperatures

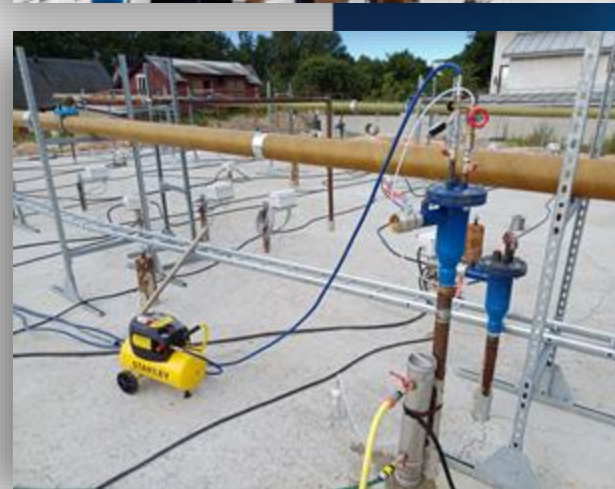


Off gas - three type of measurements



Final results

Parameter		
Volume (m³)		4.300
Energy (kWh)	Actual	1.064.030
	Estimate	1.100.000
Heating time (days)	Actual	98
	Estimate	120
All temp points > 100 °C for 10 consecutive days		Yes
Asymptotic removal < 300 g/day for at least 3 days		Yes
Remedial goals <1 000 µg/l (PCE+TCE+DCE+VC)		Yes
Avg. conc. sum CVOC: 132 ug/l, Max conc. sum CVOC: 319 ug/l		



Wrap up

- Analysis and forecasting tool
 - Simplifies operation for datamanager
 - Worked well
- Data density and transparency
 - How much data is needed?
 - Can we make a documentation standard for different technologies?
 - How transparent can we be?
 - Establish a common understanding that not all data collected can be explained within current budget!

Thank you

**Hässleholm kommun
Relement
All the colleagues at Veolia**

Any questions?