

# **BEYOND HEAT EXCHANGERS** **a novel approach** **to cooling and heat recovery**

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1. Suez Treatment Infrastructure

2. Haarslev Industries A/S

Treatment Infrastructure



# Context: the quest for green energy

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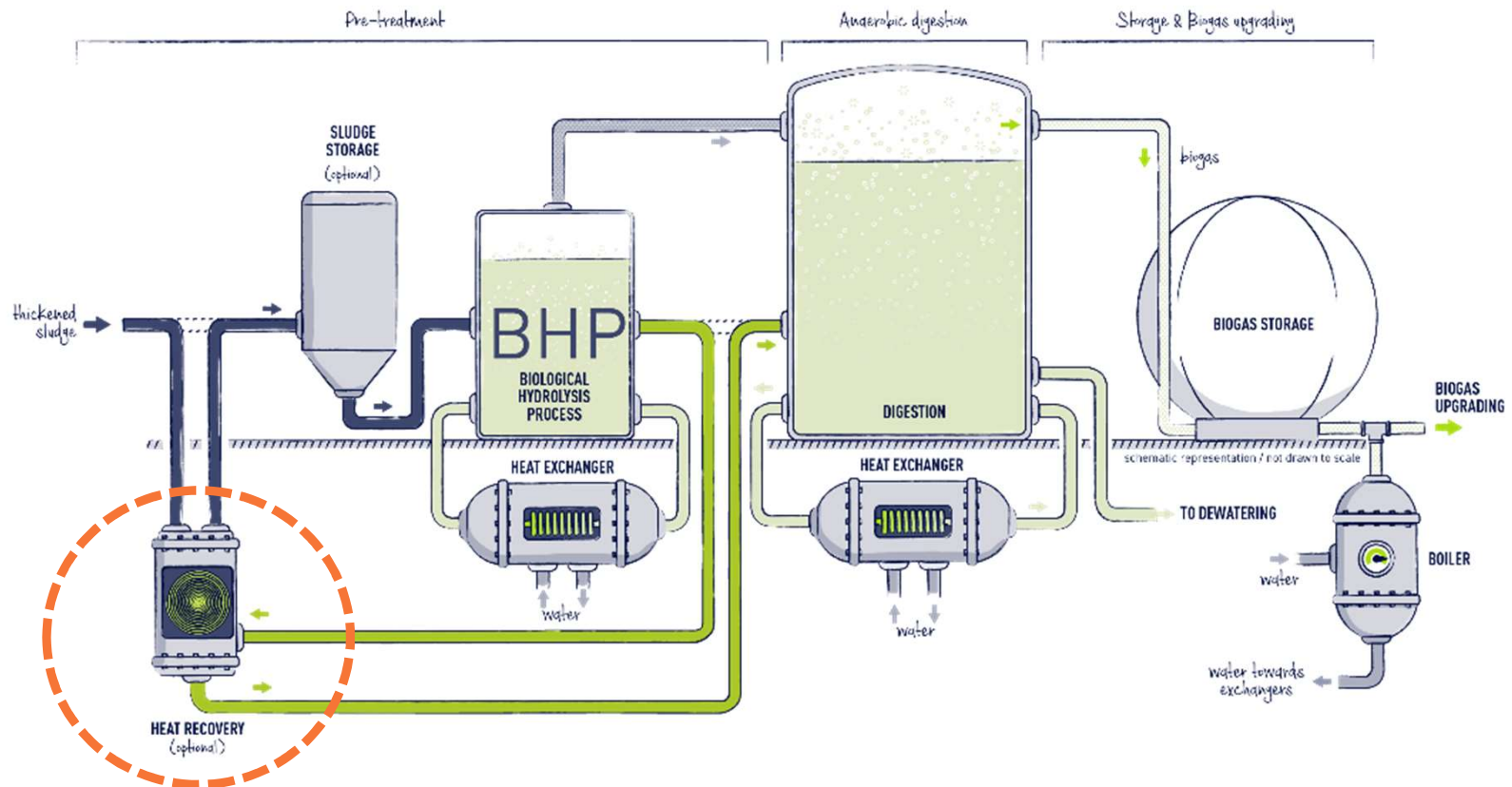
**Digelis™ BH is becoming increasingly adopted as a low-tech solution to :**

- **Increase AD performances** (increase in energy production)
- **Reduce the AD workshop footprint**
- **Produce hygienised biosolids** (US EPA Class A equivalent)

# Context: the quest for green energy

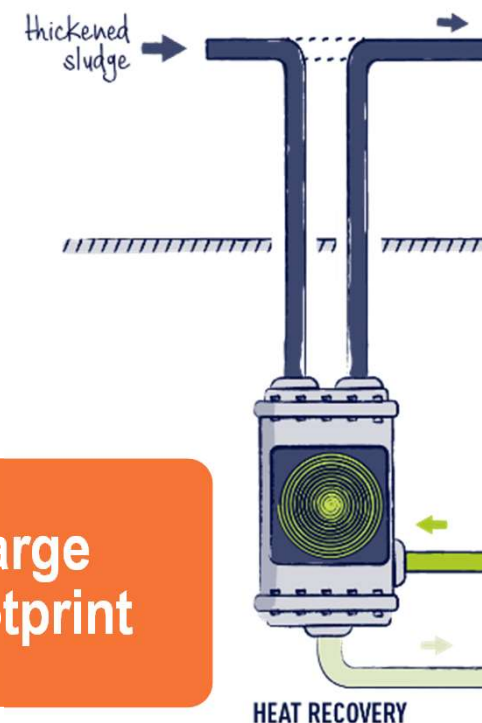
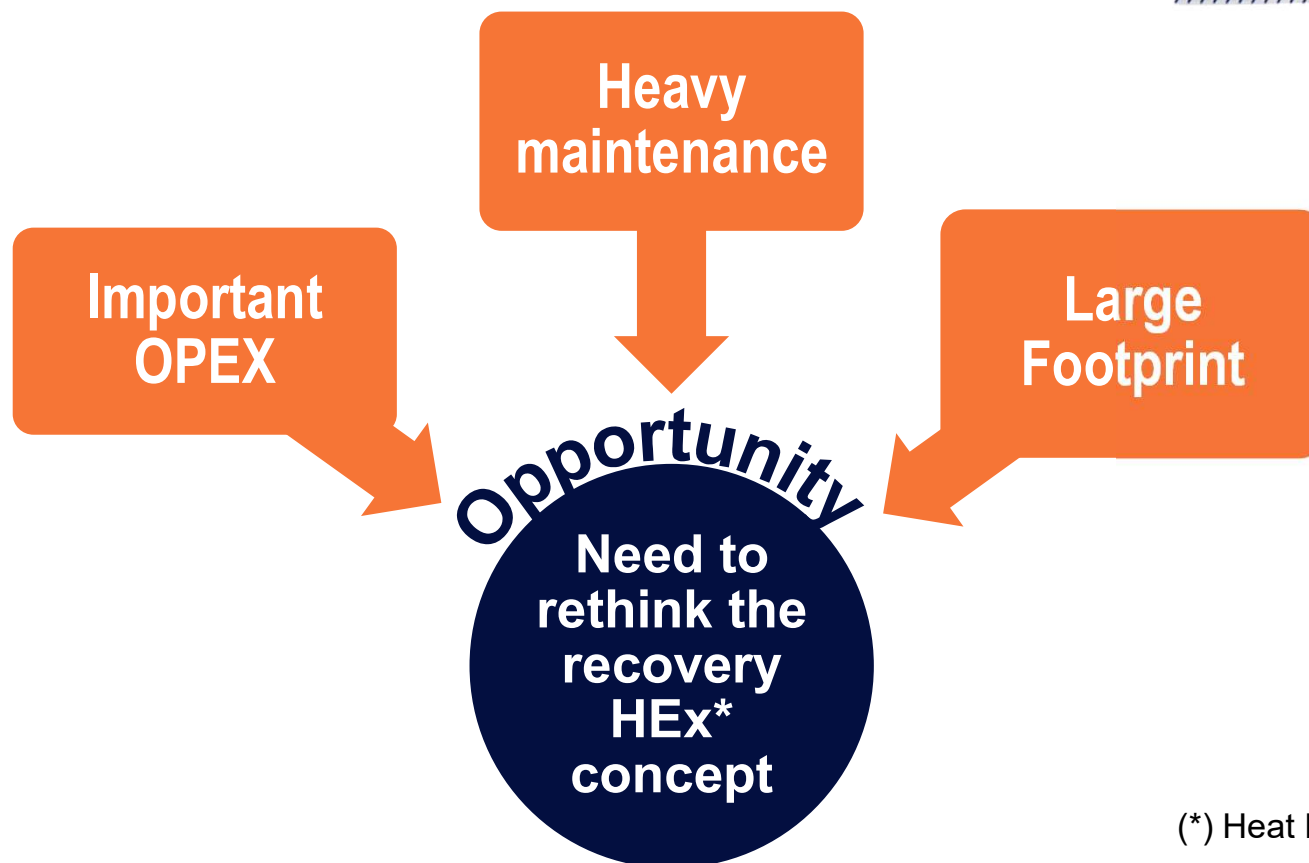
## Digelis™ BH workshop

### Advanced anaerobic digestion of activated or mixed sludge



# WHY?

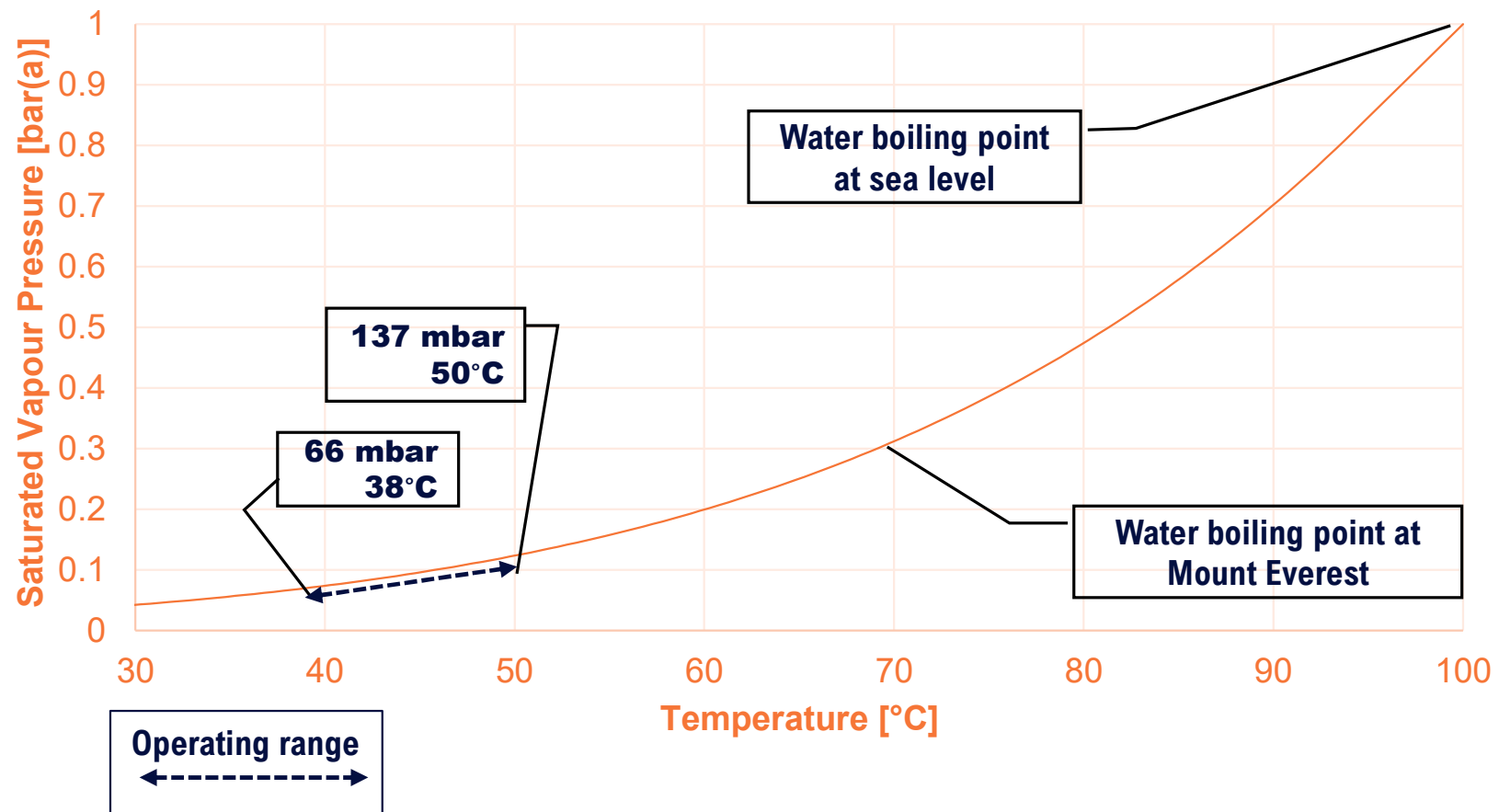
## Troublesome energy recovery



(\*) Heat Exchanger

# HOW?

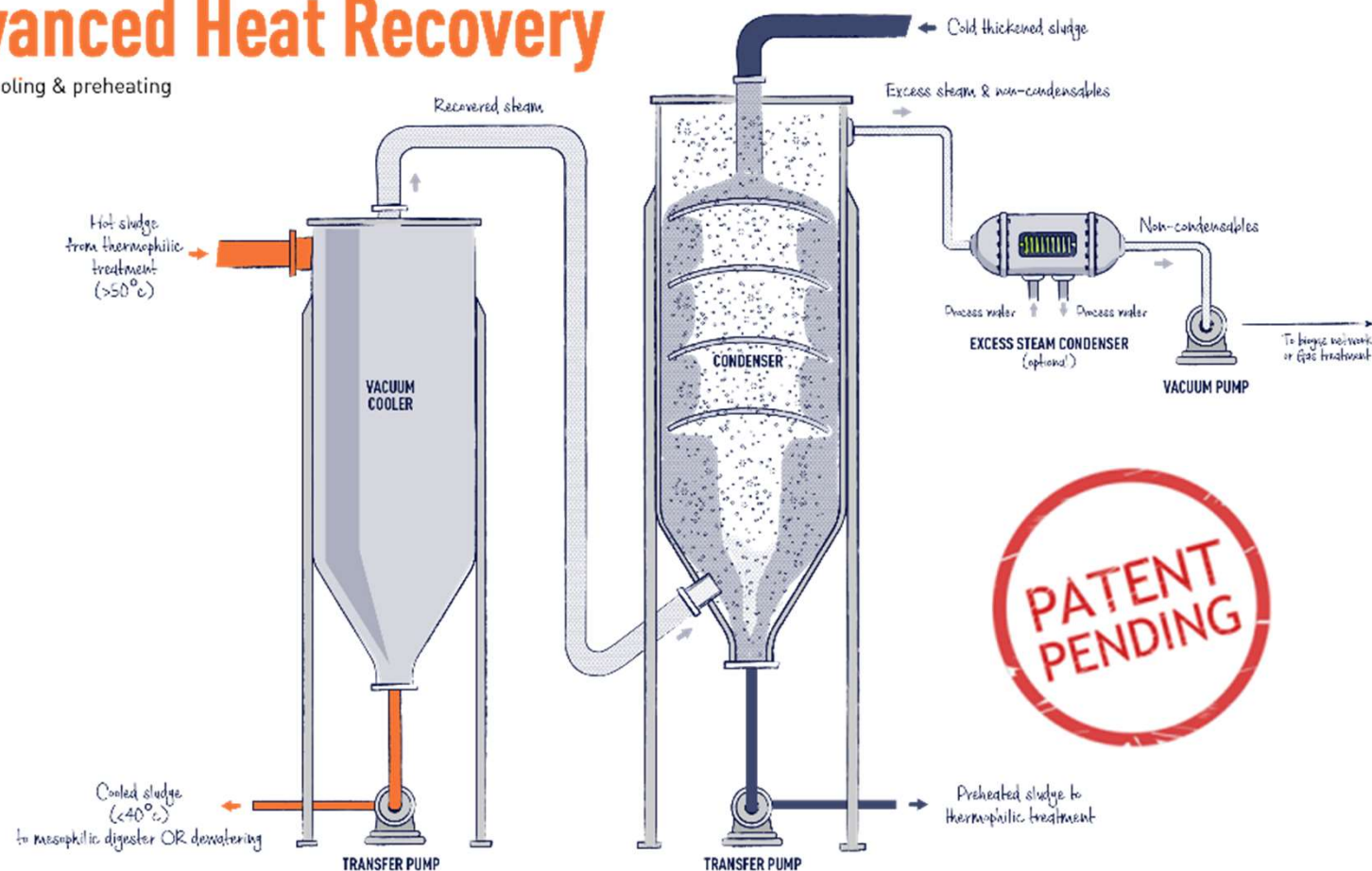
## Vacuum cooling & direct condensation



# WHAT?

## Advanced Heat Recovery

Vacuum cooling & preheating



# WHAT?

## Benefits vs. conventional recovery HEx

Sludge viscosity  
& grit settling  
have **little to no**  
influence on the  
design of the  
system

Raw sludge /  
cooling water  
temperature have  
**little influence on**  
the design of the  
system

**Significant**  
head loss

**Maintenance is**  
**significantly**  
**reduced**

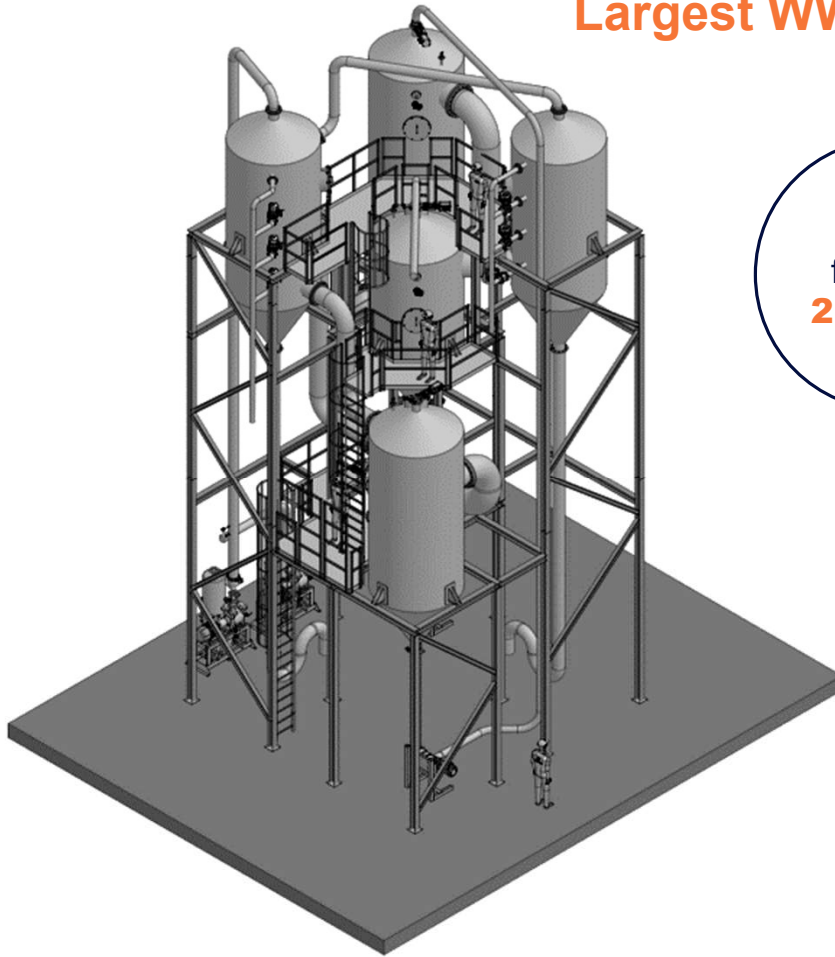
*(no scaling/no cleaning  
of heat transfer  
surface).*

**Significant**  
**footprint reduction**

*(vacuum cooling is  
instantaneous compared  
to using a HEx).*

# Advanced heat recovery: Okhla (New Delhi, India) case study

Largest WWTP in Asia – 3.5 M PE / 564 MLD



## Design

Sludge  
flowrate  
**210 m<sup>3</sup>/h**

Fresh sludge  
preheating  
temperature  
**≥ 30°C**

Hot hydrolysed  
sludge cooling  
temperature  
**38°C**

## Layout

Height  
**16.7 m**

Footprint  
**51 m<sup>2</sup>**

## Partner & Technology provider



# Value Proposition

## Advanced heat recovery Okhla case study



Heating HEx  
surface area



1/2

vs cooling only w/o  
heat recovery

100 %

self-sustainable  
workshop



Digestion

80 %

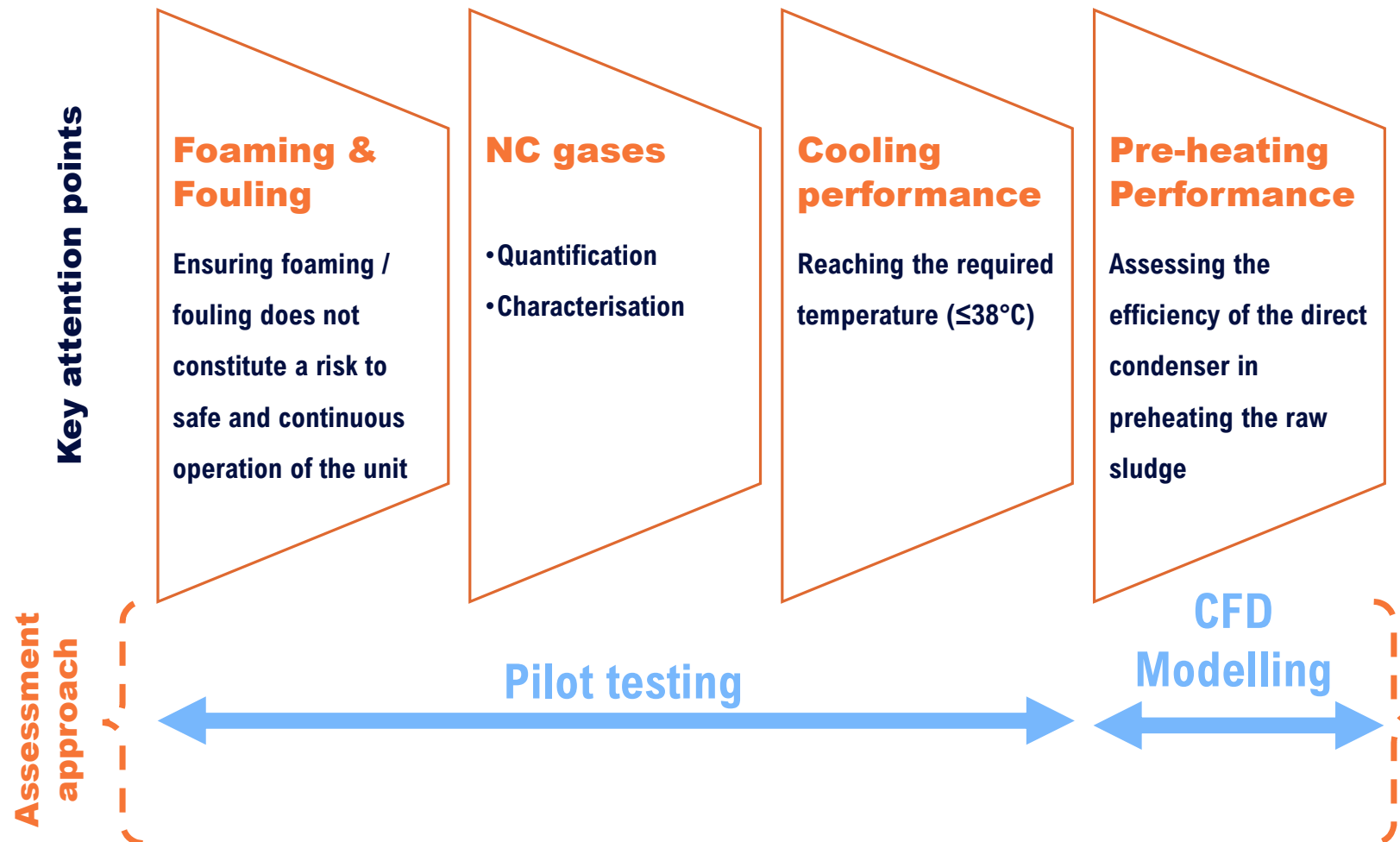
less OPEX

vs cooling only w/o  
heat recovery



Open circles are touch zones, click on it to learn more

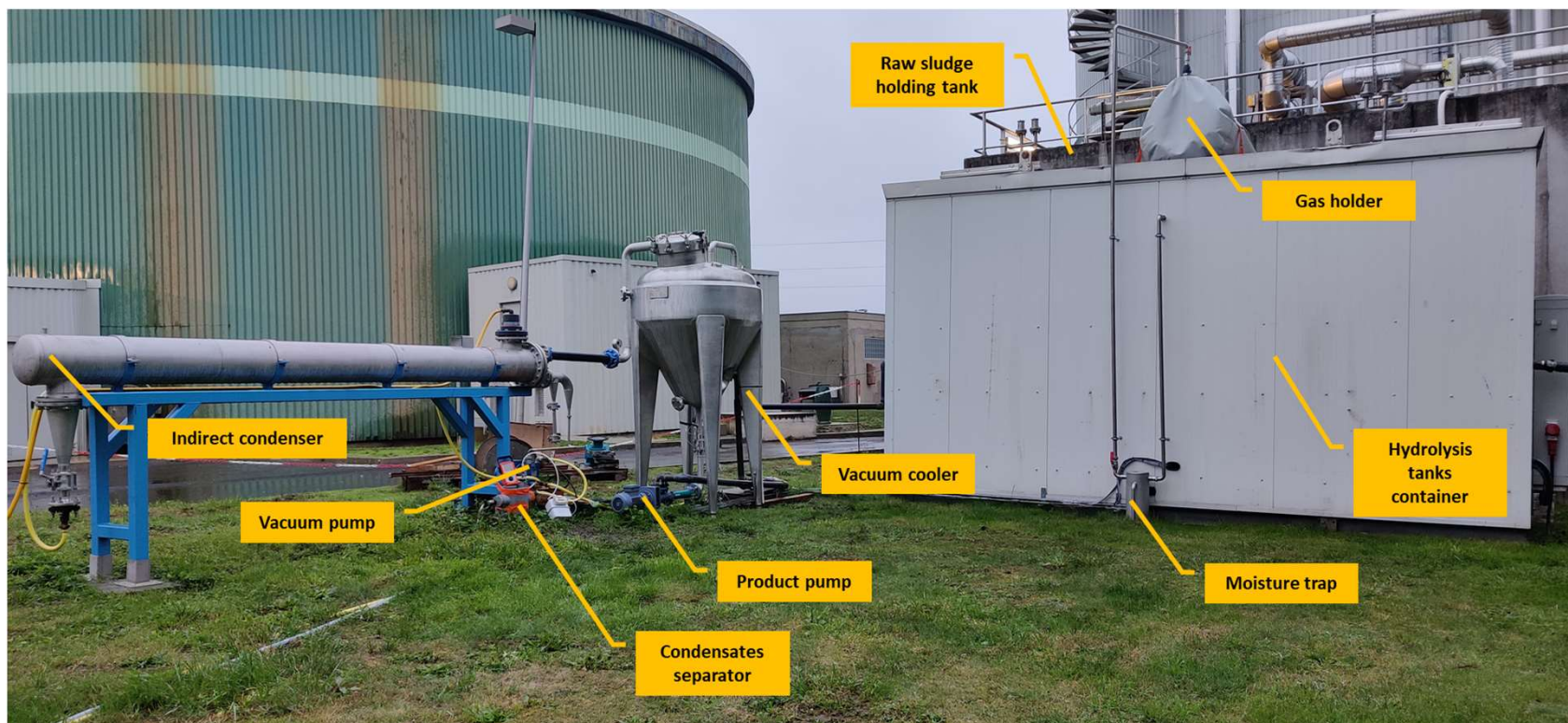
# Technology assessment



# Technology assessment

## Vacuum Cooling pilot

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# Technology assessment

## Foaming & Fouling

### Vacuum Cooler

- No foaming when operating  $\leq$ LSL for all sludge
- Foam (or sludge) recovered when  $\geq$ LSH.

→ **Foaming NOT A RISK**

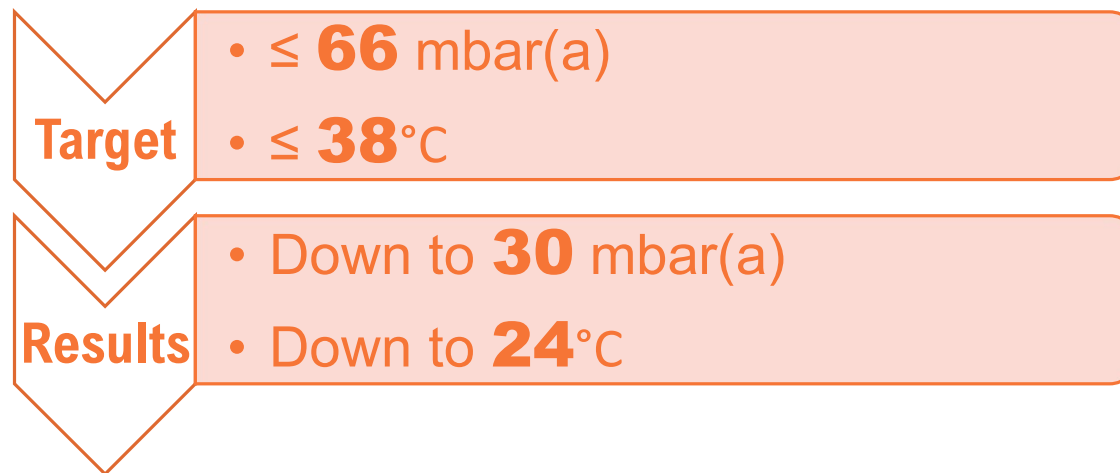
- Operating 6 months without cleaning with no impact on cooling performances

→ **Fouling NOT A RISK**



# Technology assessment

## Cooling performance



- ➔ Stable operation throughout the 4-month run,
- ➔ Non-condensable flowrate and composition remained constant,
- ➔ Vacuum cooling of the thermophilic sludge down to <38°C was successful.

# Technology assessment

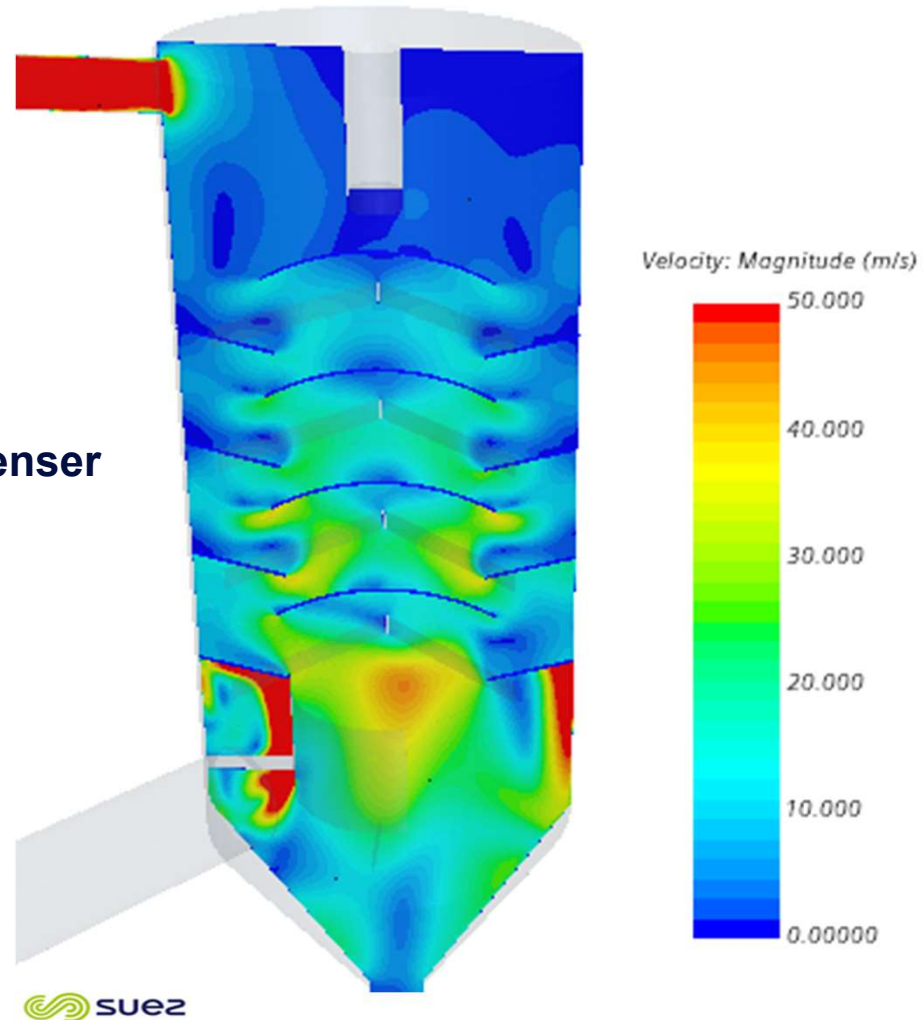
## Pre-heating Performance / CFD modelling

Establishing a condensation Model to determine:

- Velocity of vapour in the condenser
- Pressure drop in a condenser

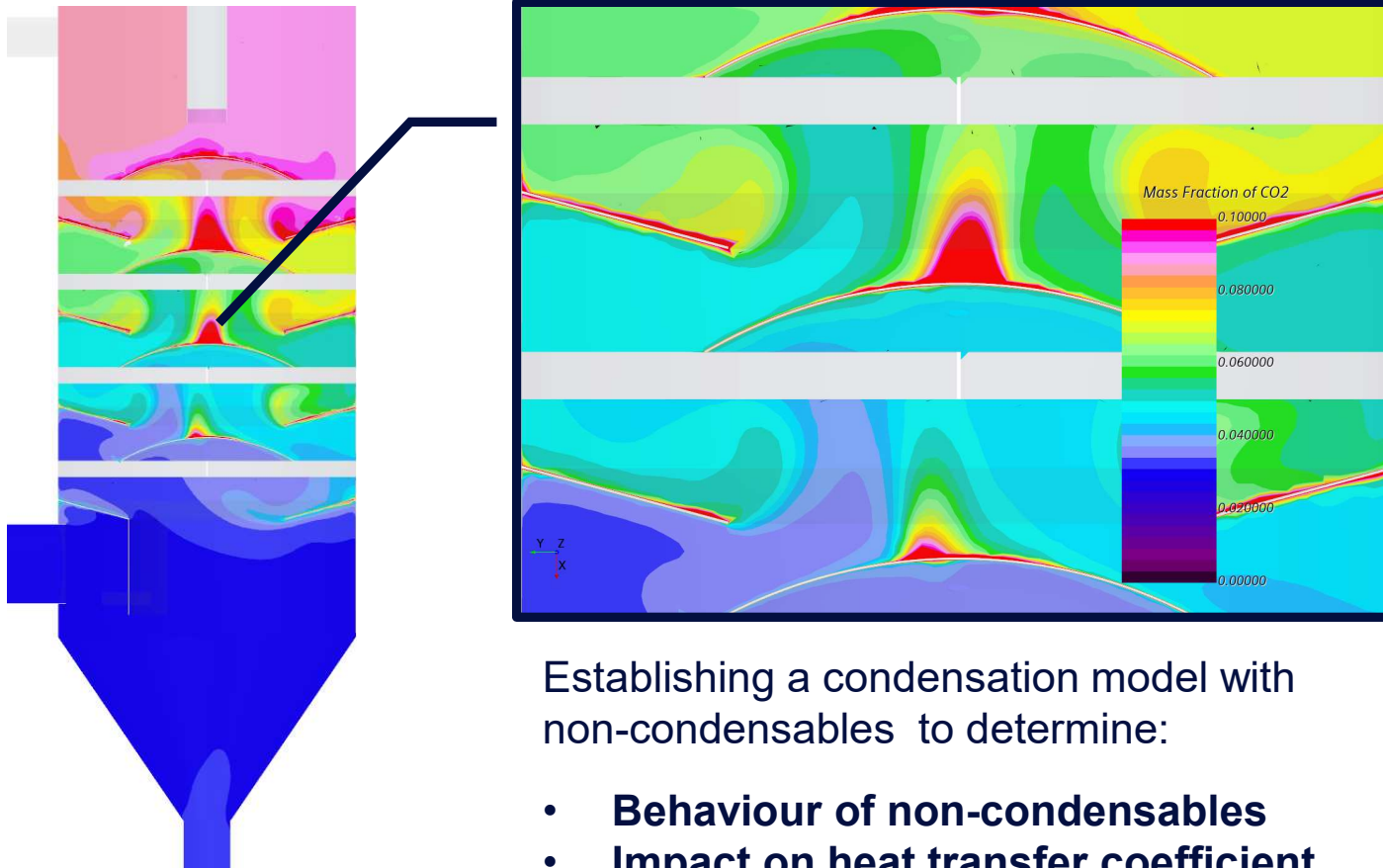


| Advanced Heat Recovery



# Technology assessment

## Pre-heating Performance / CFD modelling

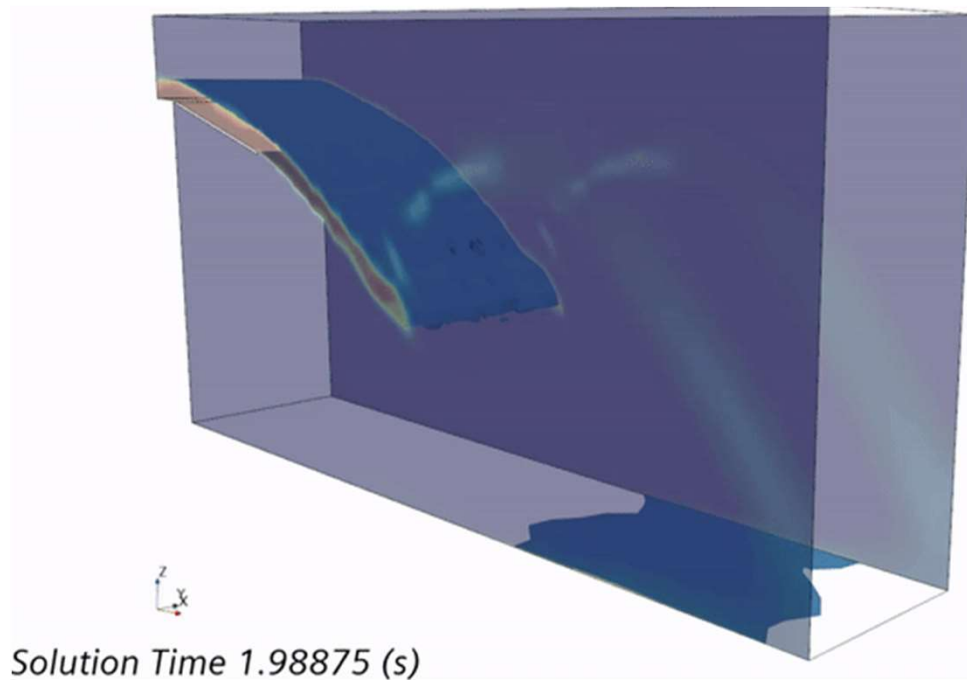


Establishing a condensation model with non-condensables to determine:

- **Behaviour of non-condensables**
- **Impact on heat transfer coefficient**

# Technology assessment

## Pre-heating Performance / CFD modelling

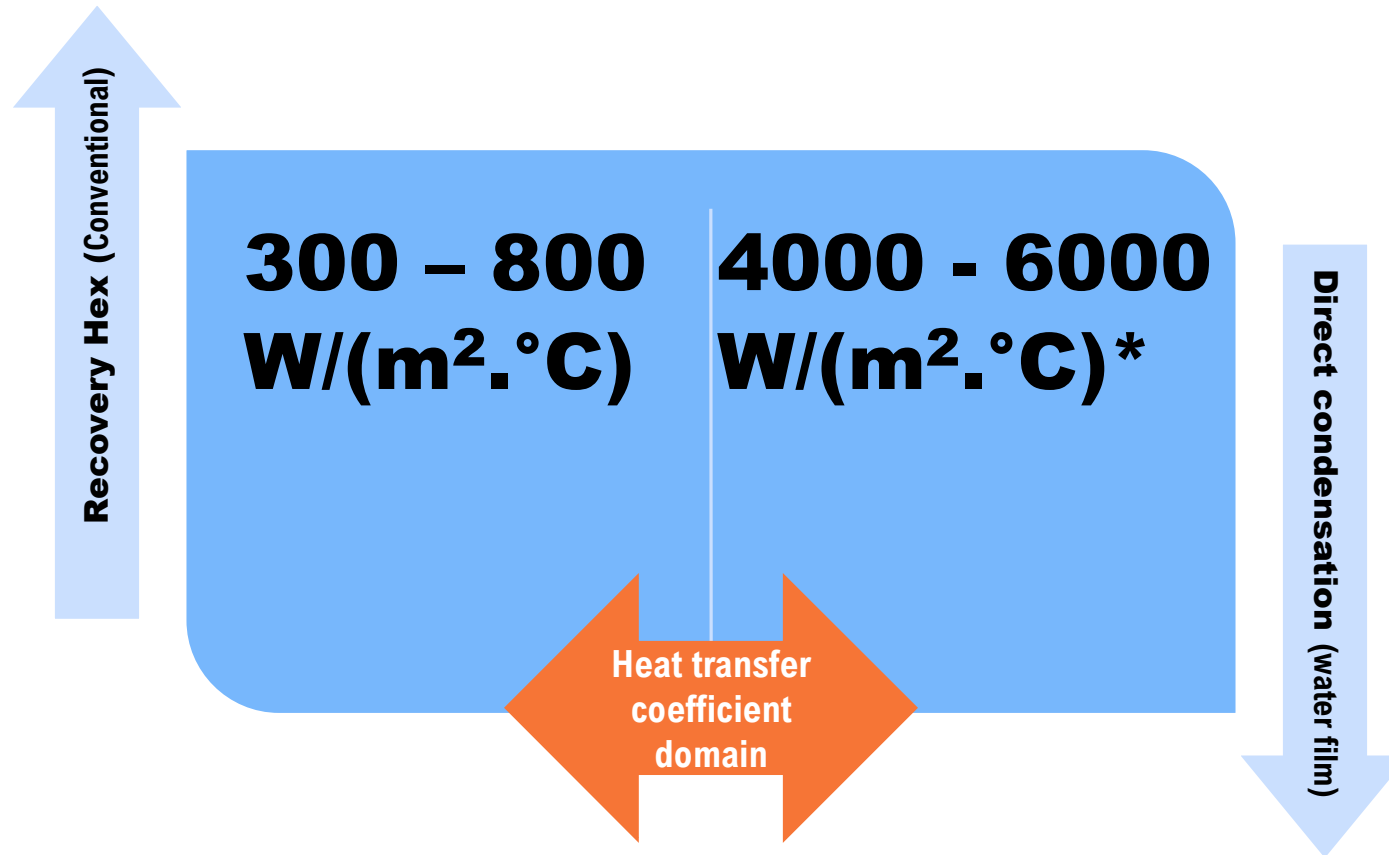


**Establishing a flow model of the sludge to determine an average surface area on different surfaces (curtain & plates)**



# Technology assessment

## Pre-heating Performance / CFD modelling



(\*) Bergman, T. L., & Incropera, F. P. (Éds.). (2011). *Fundamentals of heat and mass transfer* (7th ed). Wiley.

# Technology assessment

## Conclusion

### Key attention points

#### Foaming & Fouling

Ensuring foaming / fouling does not constitute a risk to safe and continuous operation of the unit

#### NC gases

- Quantification
- Characterisation

#### Cooling performance

Reaching the required temperature ( $\leq 38^{\circ}\text{C}$ )

#### Pre-heating Performance

Assessing the efficiency of the direct condenser in preheating the raw sludge

## PROOF OF CONCEPT VALIDATED