MVM EGI

ACC OF LARGEST WASTE TO ENERGY PLANT UNDER CONSTRUCTION IN POLAND

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ABOUT MVM EGI

Profile: Globally active cooling system provider
Consultancy, design, engineering, delivery, after sales

Manufacturing: Fully owned factory in Wuqing, CN

Founded in 1948 as EGI
GEA Group 1992-2014, ENEXIO 2014-2020

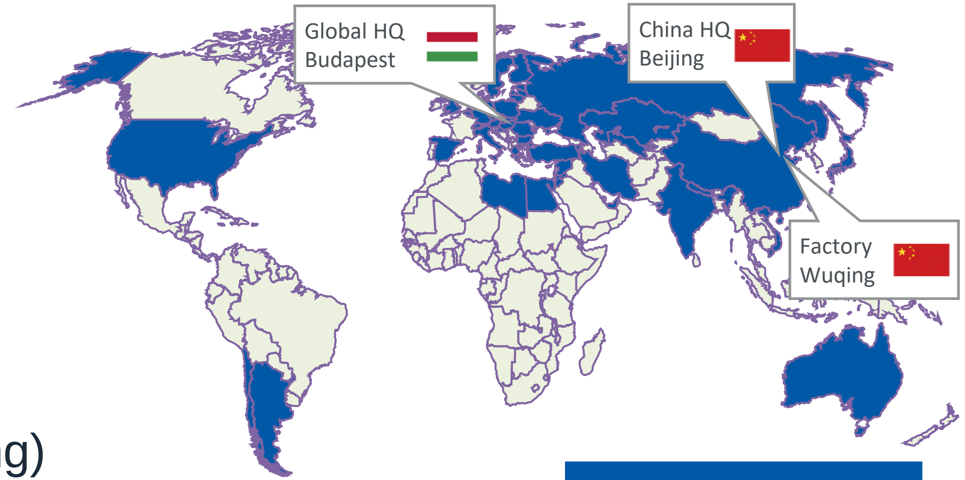
Financials: 57.8 mn € net revenue in 2020
Stable, profitable company in the past 20+ years

Owner: MVM Group *(100% Hungarian state owned)*
The largest power-utility company in CEE region

Headcount (FTE): 124 (68 Budapest, 24 Beijing, 32 Wuqing)
Headquarters: Budapest, Hungary

MVM EGI Factory in Wuqing, China

Global supply track record



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ABOUT MVM EGI

Technology leader with strong Hungarian engineering heritage

Organization milestones

- **1948** – Foundation of EGI by Prof. Dr László Heller and Dr. Lászlo Forgó

- **1968** – Heat exchanger workshop starts production in Jászberény, Hungary
- **1992** – Acquisition of EGI by GEA Group *(German Industrial Conglomerate)*

GEA-EGI

- **2008** – New heat exchanger production site in Wuqing, China

- **2014** – Acquisition of EGI by Triton Partners *(German Private Investment Fund)*

Triton

- **2015** – Brand change from EGI to ENEXIO

ENEXIO

- **2021** – Acquisition of ENEXIO Hungary by MVM Group

mvm group

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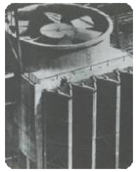
Technology milestones

- **1954** – First pilot-plant scale Heller system

- **1962** – First mechanical draft indirect cooling tower *Eilenburg Chemical Works, Germany*



- **1972** – First dry cooled nuclear power plant Mechanical draft indirect cooling towers *Bilibino NPP, Russia*

- **1984** – First hybrid cooler *Great Isfahan Power Station, Iran*

- **1994** – First hybrid cooler in the USA *Neil Simpson Power Station, Wyoming, USA*

- **2020** – Next generation mechanical draft indirect dry cooling tower, *Avtovo PP, Russia*

- **2022** – Air-Cooled Condenser for *Waste to Energy Plant, Warsaw, Poland*

ABOUT MVM GROUP

The largest power utility company in the CEE region

7.1 BILLION EUR SALES	**655** MILLION EUR EBITDA	**3RD** LARGEST COMPANY IN HUNGARY BY SALES	**13TH** LARGEST COMPANY IN CENTRAL EUROPE BY SALES	**90,372** KM OF TRANSMISSION AND DISTRIBUTION LINE NETWORK
11M DIRECT CUSTOMERS	**41 TWH** OF ELECTRICITY SOLD/YEAR	**176** TWH OF NATURAL GAS SOLD/YEAR	**4.4B M³** OF NATURAL GAS STORAGE CAPACITY	**18,000** EMPLOYEES

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PRODUCT PORTFOLIO

Excellence in engineering and highest quality project execution

		HELLER INDIRECT DRY COOLING	AIR-COOLED CONDENSERS	EVAPORATIVE COOLING TOWERS	HYBRID DRY/WET COOLING TOWERS	DRY COOLING SPECIAL APPLICATIONS	CIRCUMIX ASH HANDLING
POWER PLANTS	COAL FIRED	x	x	x	x	x	x
POWER PLANTS	COMBINED-CYCLE	x	x	x	x	x	
POWER PLANTS	NUCLEAR	x		x	x	x	
POWER PLANTS	BIOMASS & W2E	x	x	x	x	x	
POWER PLANTS	CONCENTRATED SOLAR	x	x	x	x	x	
	DATA CENTERS	x		x	x	x	
	CHEMICAL PLANTS	x		x	x	x	
	INDUSTRIAL APPLICATIONS	x	x	x	x	x	

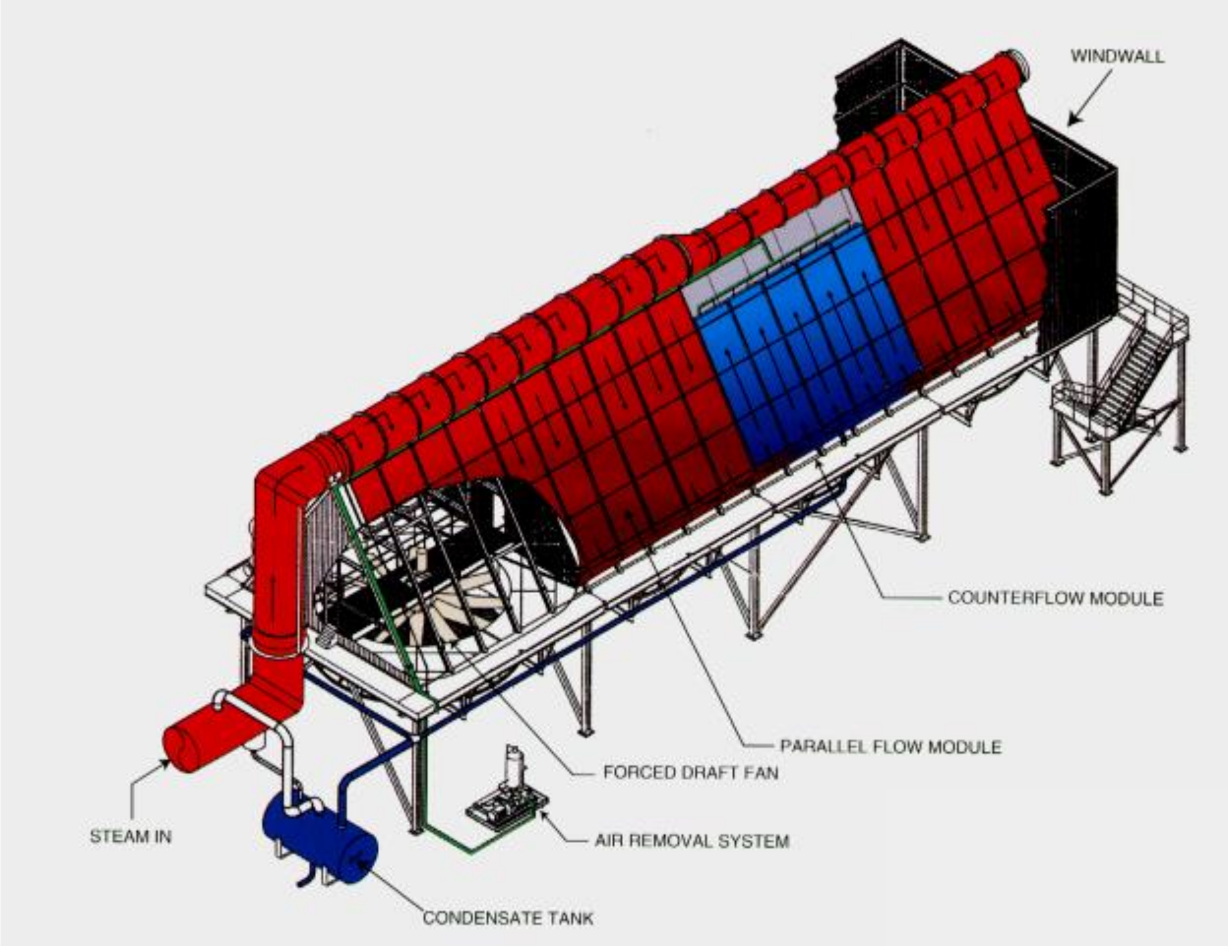
COOLING OF WASTE TO ENERGY PLANTS

Air Cooled Condensers provide an environmentally friendly dry cooling solution for waste to energy plants

Waste to energy plants are usually situated in or in the close proximity of cities.

This provides unique challenges for the cooling system, which can be fulfilled with an ACC:

- Zero water consumption
- Low-noise operation
- Ease of operation and maintenance
- Small visual footprint
- No plume
- Cost effective dry cooling solution
- Compact design, efficient plot area use



ACC SOLUTIONS

The Air-Cooled Condenser solutions of MVM EGI are highly competitive in the international market

Our company has decades of experience with dry cooling systems, having been members of the GEA Group, later ENEXIO, the inventor of the ACC

The source of our competitiveness:

- Long history, decades of experience designing cooling systems
- In-house Research & Development
- Cost effectiveness
  - Skilled, high value-added engineering team in Hungary, one of the most attractive locations in terms of costs in the EU
  - Cost effective sourcing options from our daughter company in China
- Experience in highly constrained urban environments

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WARSAW WASTE TO ENERGY PROJECT

Characteristics of the project:

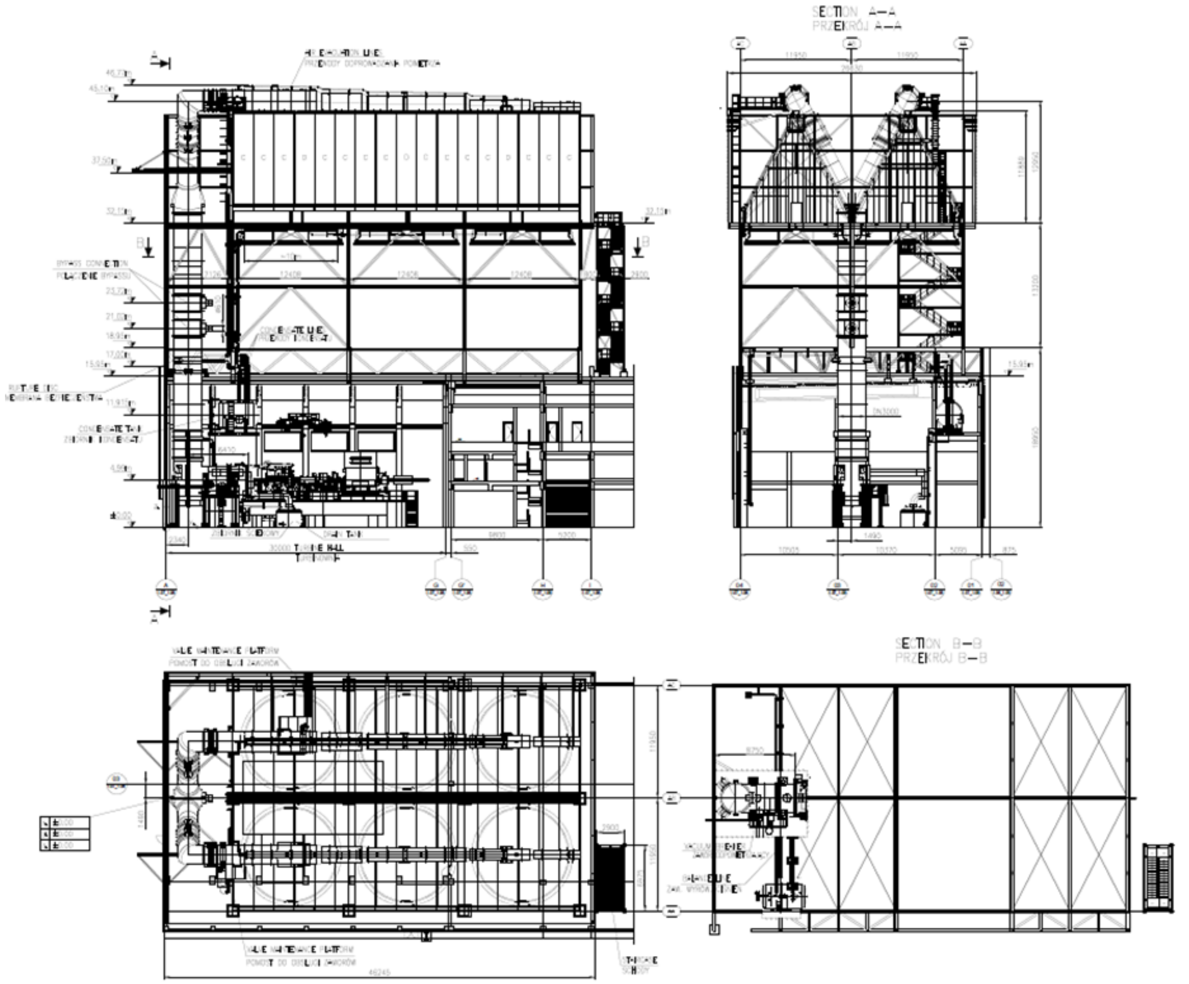
- **EPC: POSCO E&C**
- **Electricity generated: 25 MW**

  Largest Waste to Energy project in Poland
- **District heating capacity: 54 MW**
- **Thermal characteristics of the ACC:**
  - Heat load: **51 MWth**
  - Design steam flow: **90 t/h**
  - Minimum ambient temperature: **-30 °C**
  - Design temperature**: 25.3 °C**

WARSAW WASTE TO ENERGY PROJECT

Main challenges

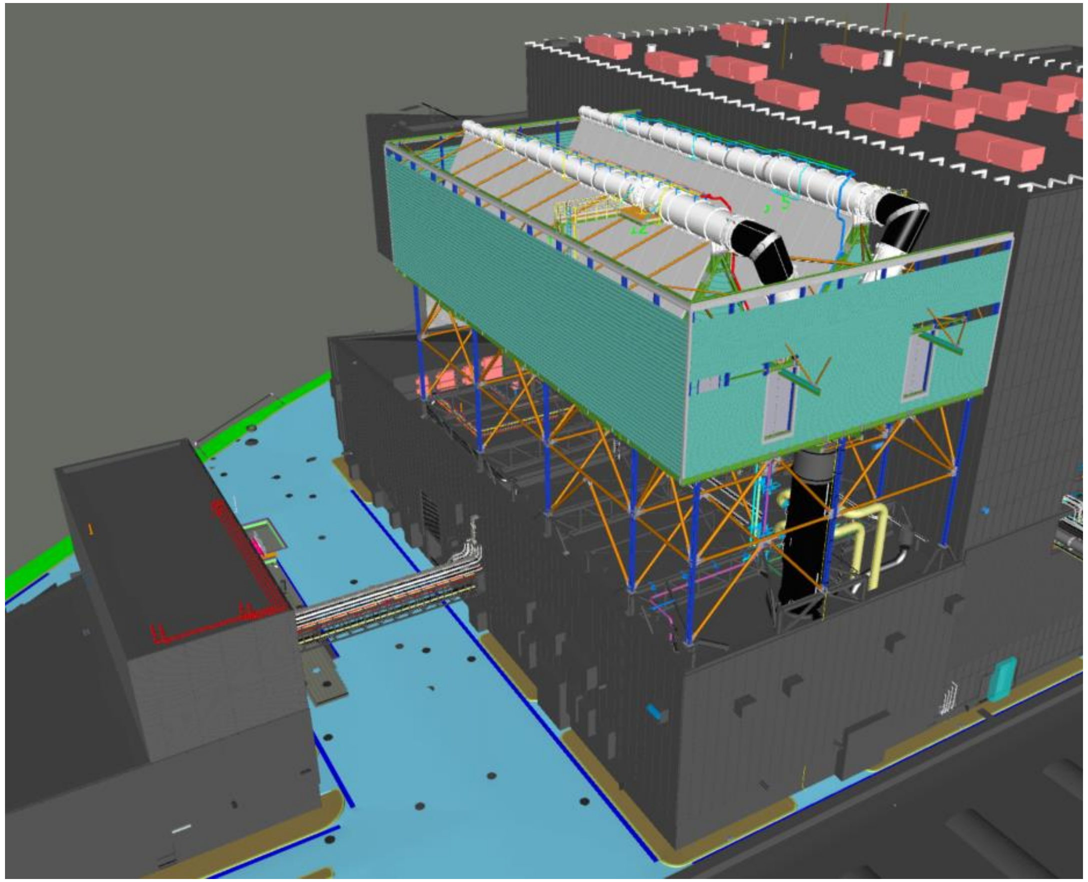
- ACC is located on the roof of the turbine hall
- Limited space for the ESD
- Unique requirements for air evacuation
- Low steam flow while operating in cold weather



WARSAW WASTE TO ENERGY PROJECT

ACC mounted on the roof of the steam turbine building

- **Unique wind and seismic characteristics**
  - Wind load characteristics altered by the turbulent airflow caused by the boiler building and high elevation
  - Wall next to the ACC restricts airflow from one direction
  - CFD wind load calculation was deemed necessary
- **Required tight coordination with the civil engineering team**
  - Iteration for the optimal static design of the roof structure
  - Iterative adjustments to the foundation of the building
    - End result – extended piling under the turbine hall



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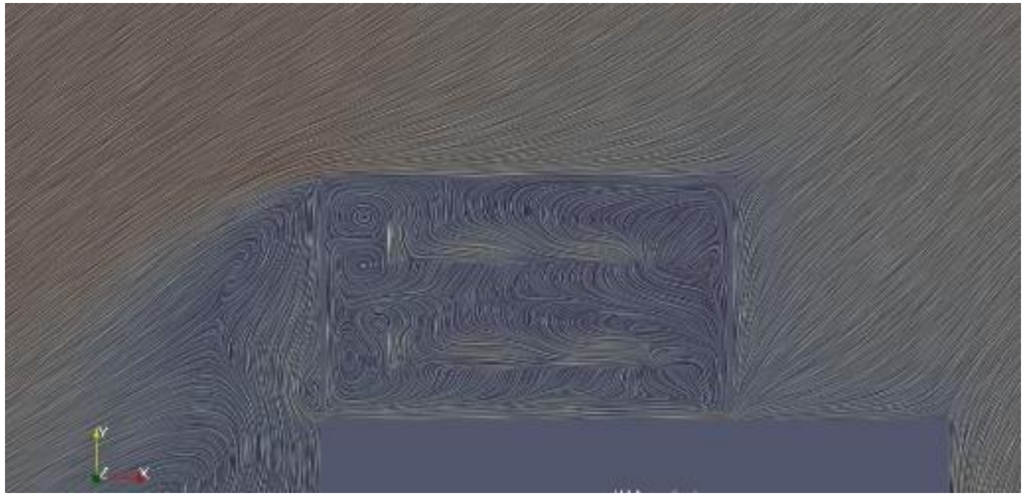
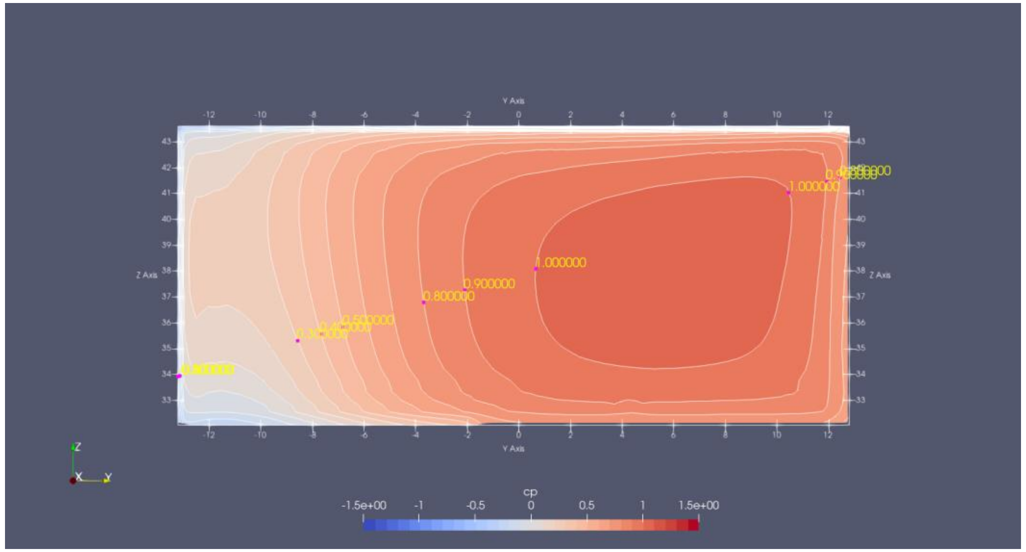
WARSAW WASTE TO ENERGY PROJECT

CFD analyses of the ACC

- **Analyses conducted:**
  - Wind loads on the steel structures of the ACC
- **Software tool:**
  - OpenFOAM – a powerful, free-to-use, open source CFD analysis tool
- **Geometry:**
  - CAD models and scripted heat exchanger geometries
- **Meshing:**
  - Body fitted cut-cell cartesian mesh

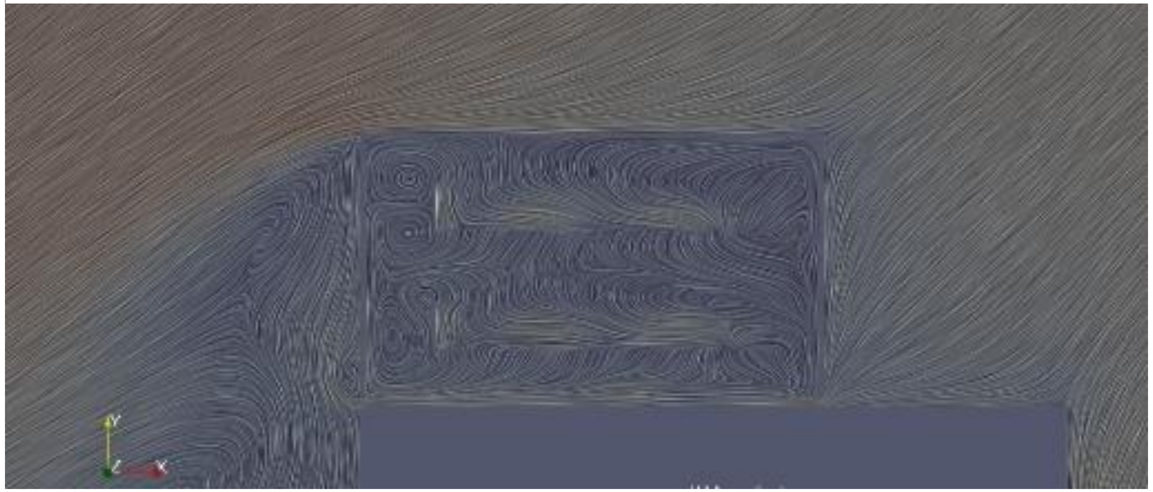


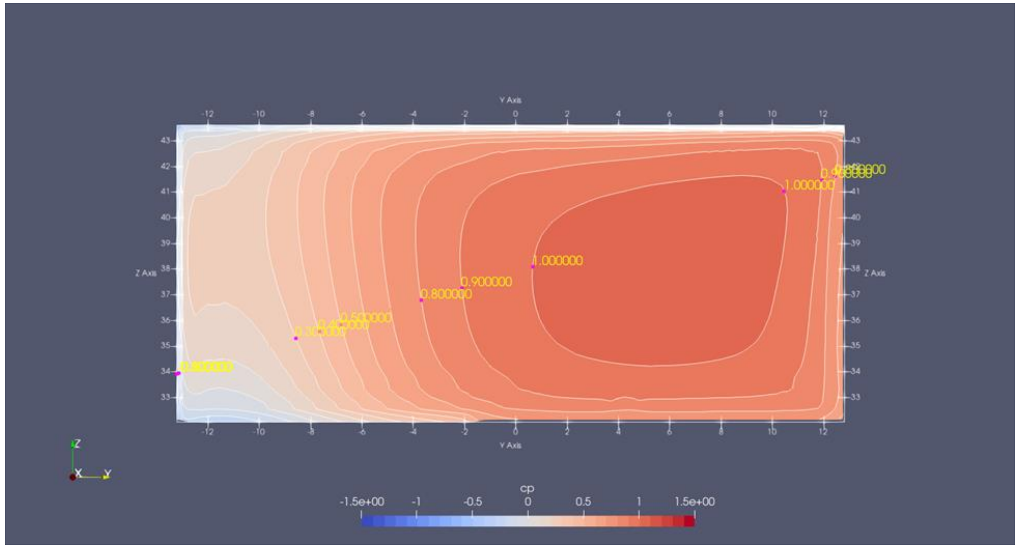


WARSAW WASTE TO ENERGY PROJECT

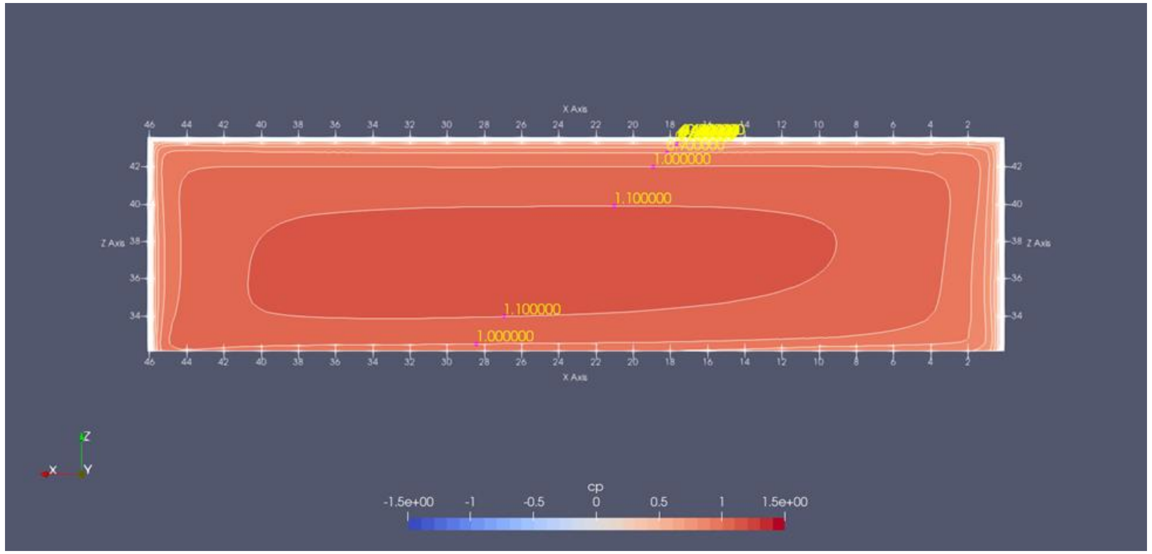
Wind load CFD calculation

- **Standard sizing resulted in an oversized steel structure**
  - Main load on the steel structure induced by the wind pressure acting on the windwalls
  - CFD analysis to find the optimal design
  - Wind loads determined from the CFD calculation


Sectional streamlines in a horizontal plane



Pressure coefficient distribution on the *south* windwall

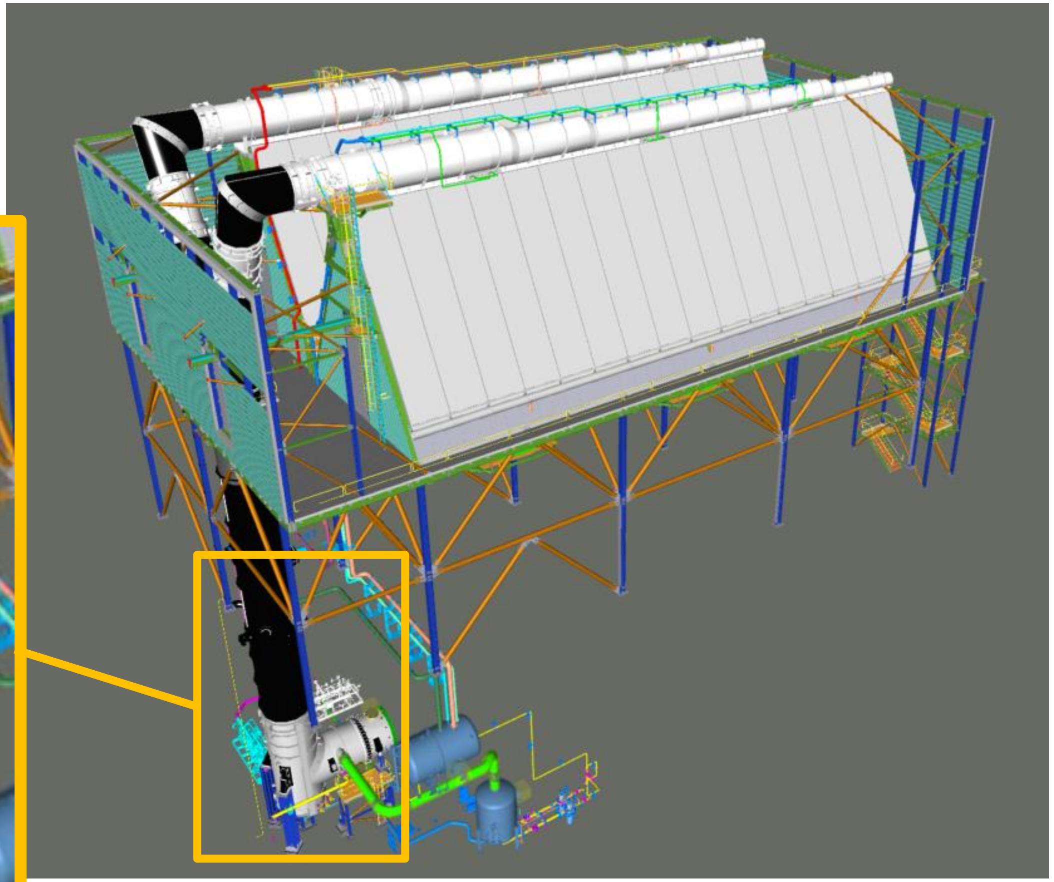


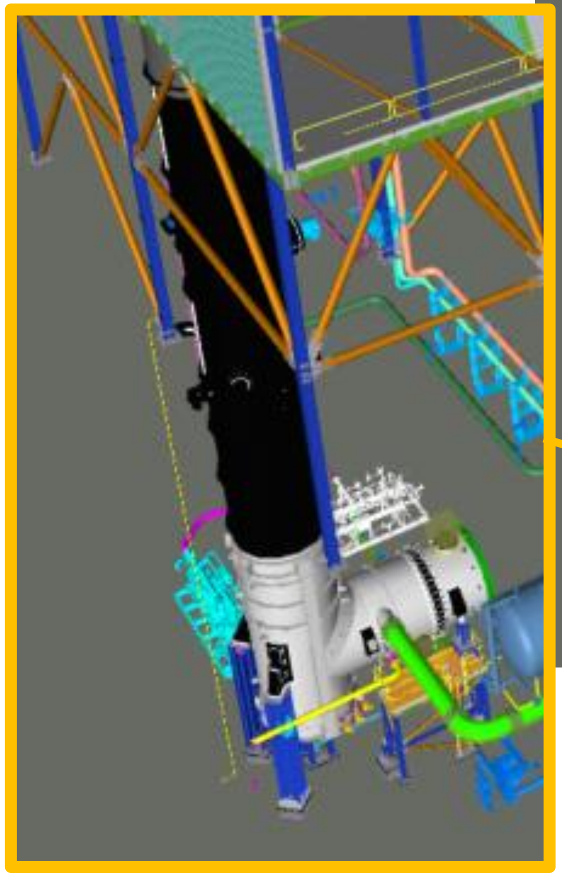
Pressure coefficient distribution on the *east* windwall

WARSAW WASTE TO ENERGY PROJECT

Limited space for the Exhaust Steam Duct (ESD)

- **Requires special solution for the Expansion Joints**
- **FEM analyses on the load bearing parts of the ESD to optimize the design**
  - Elbows between the ESD and SDD
  - ESD Y-branch





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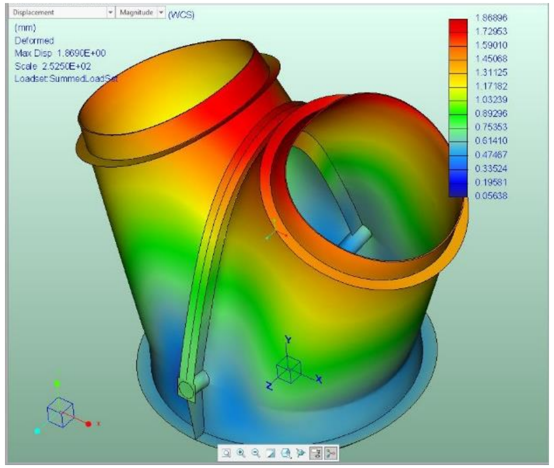
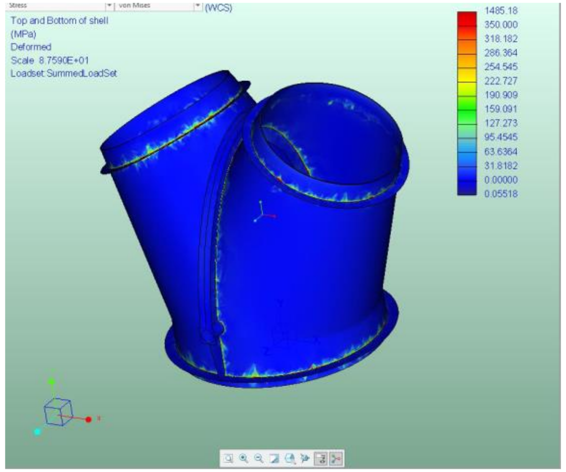
WARSAW WASTE TO ENERGY PROJECT

FEM analysis of the critical components of the ESD

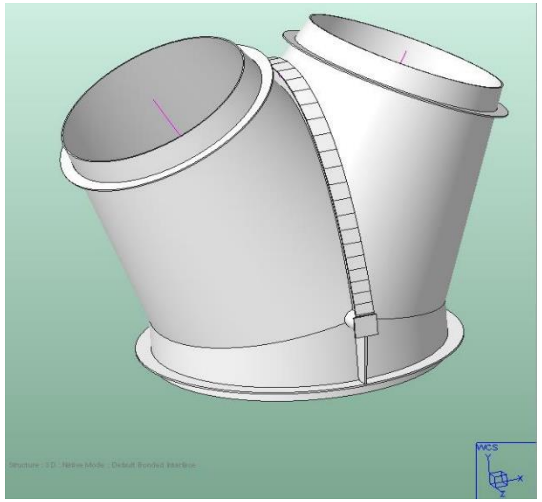
- **Analysis conducted on the most pivotal parts of the ESD**
  - Elbows between the ESD and SDD
  - ESD Y-branch

Displacements and Stresses of the ESD Y-branch

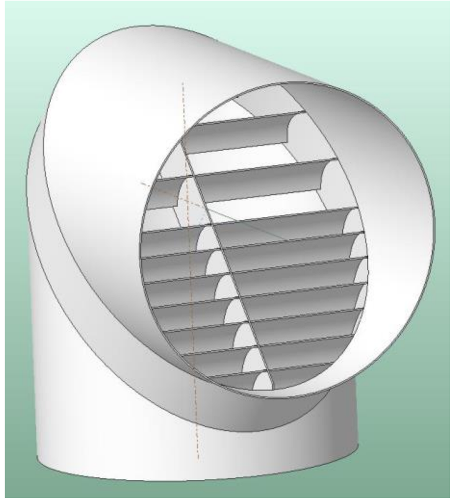




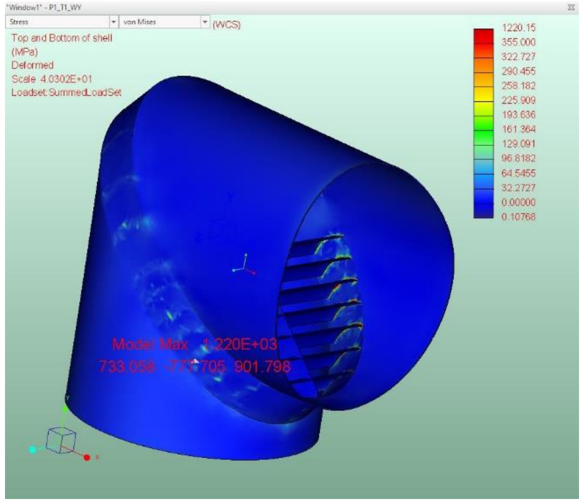
ESD Y-branch

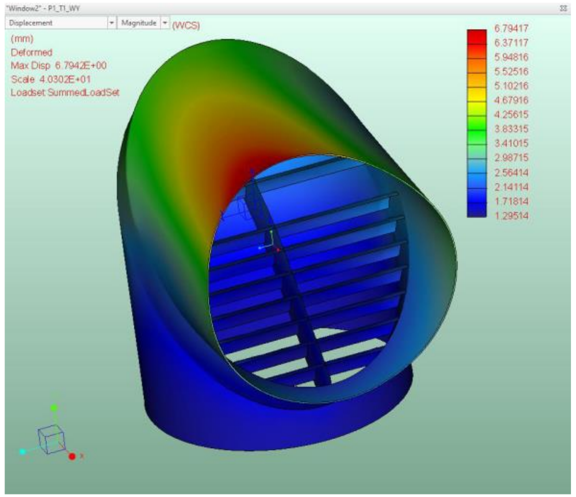


SDD/ESD connecting elbow



Displacements and Stresses of the SDD/ESD connecting elbow





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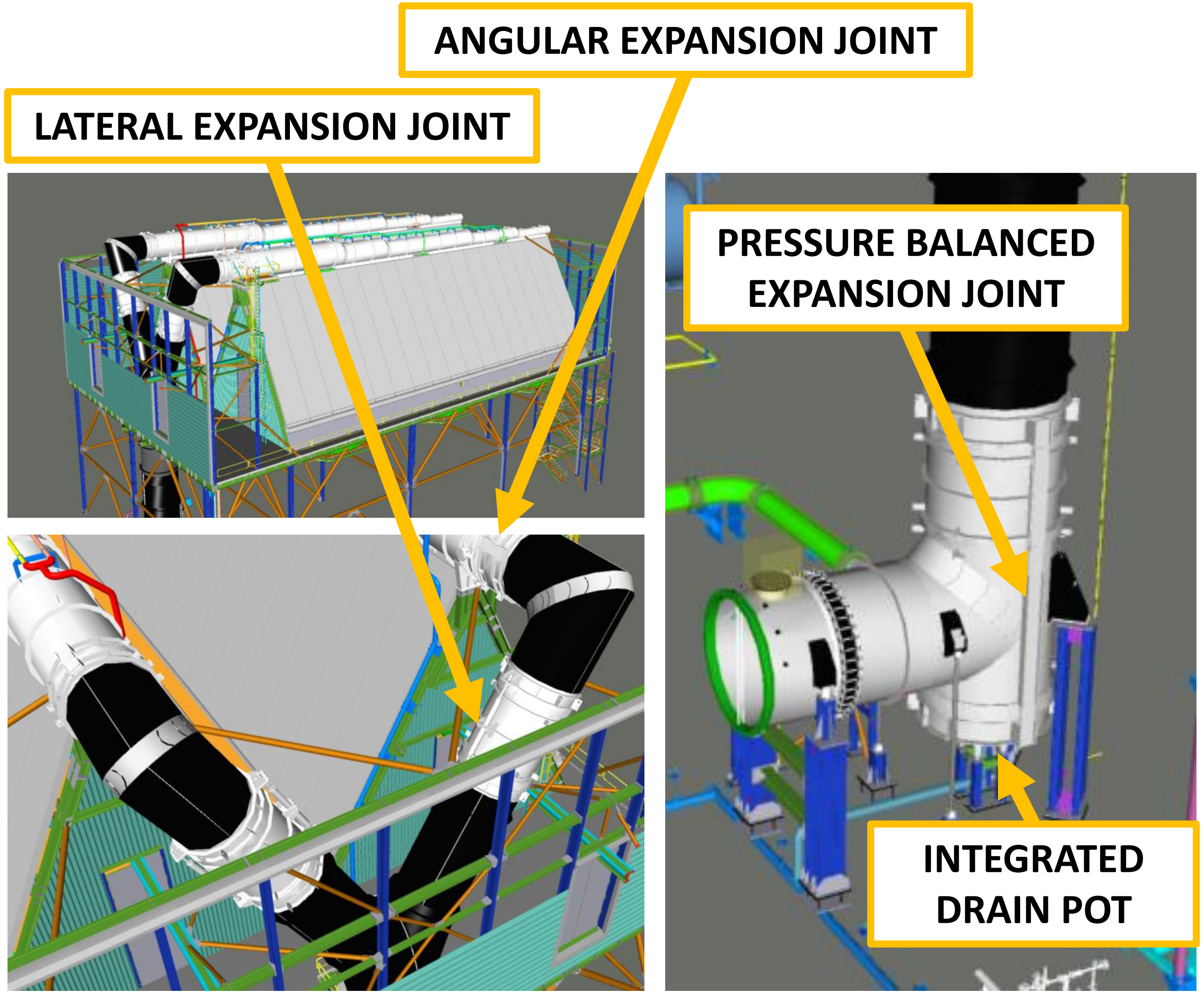
Limited space for the Exhaust Steam Duct (ESD)

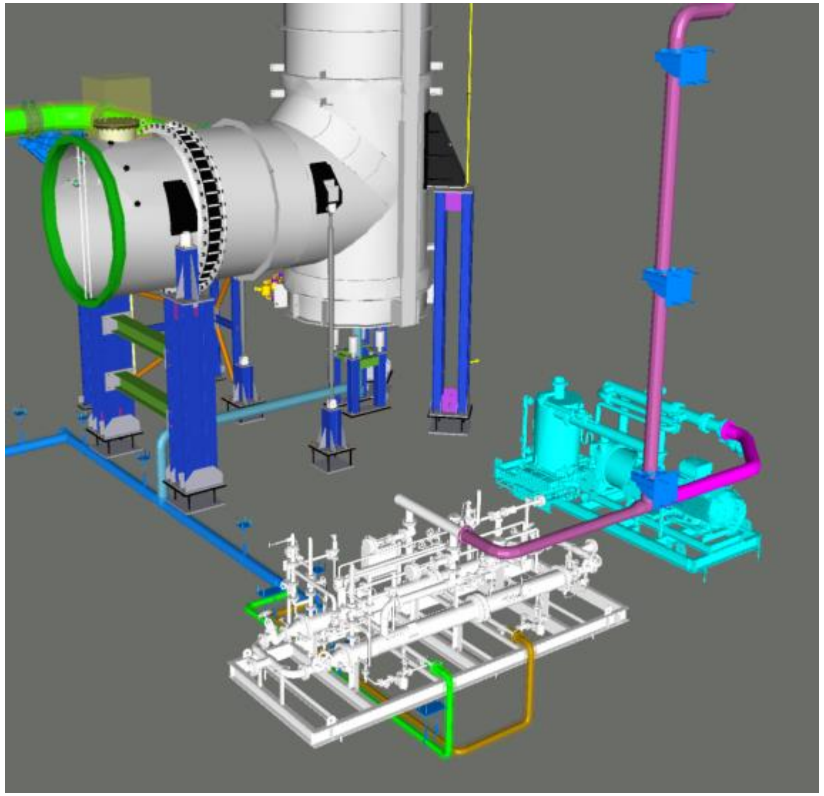
- **Required special solution for the Expansion Joints**
  - Long vertical and relatively short horizontal steam duct routing, which results in large thermal displacement in the vertical direction (normally absorbed by a lateral expansion joint)
  - Only ~4 m horizontal duct for the DN3000 lateral expansion joint would have been available, therefore an alternative solution was implemented:
  - In-house specification for a pressure balanced expansion joint instead of a lateral one. This solution is rare in the world of ACCs
  - Drain pot integrated into the Pressure Balance Expansion Joint.
  - Iterative cooperation with the expansion joint manufacturer to reach the final design



WARSAW WASTE TO ENERGY PROJECT

Unique requirements for the air evacuation

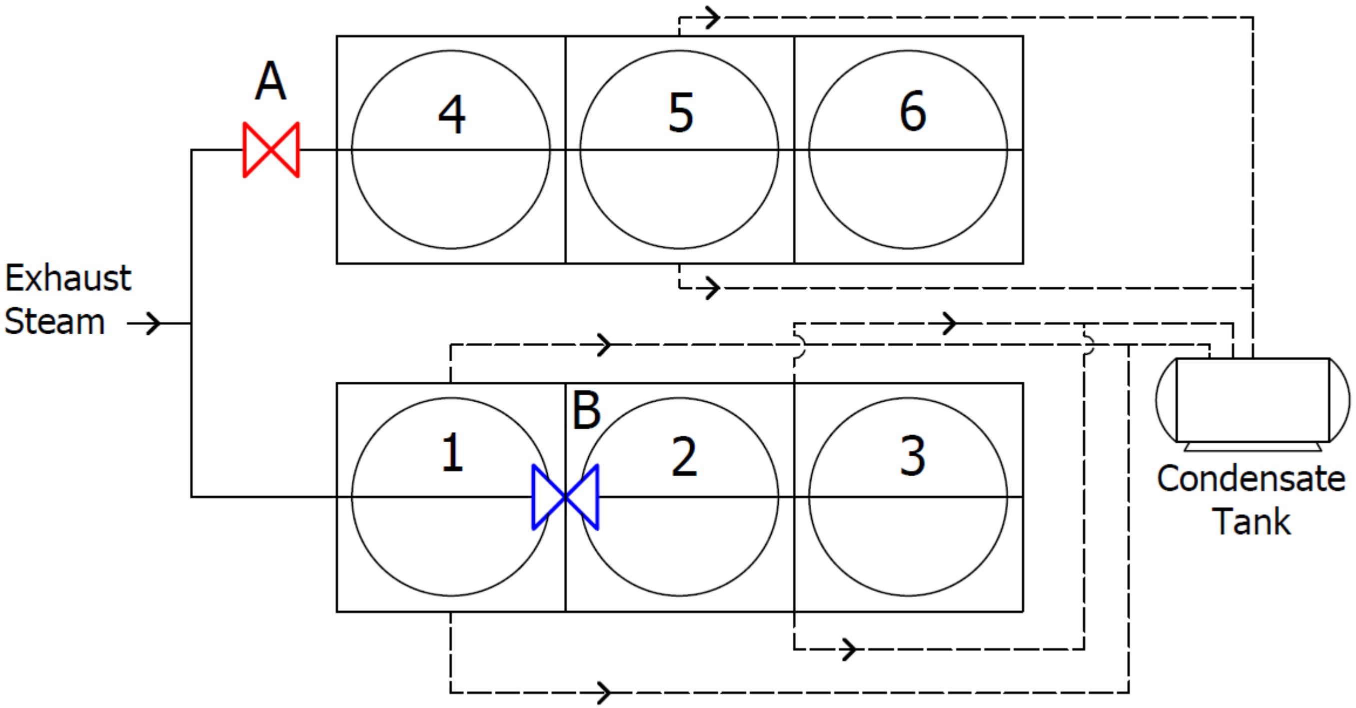
- **Hogging duty: 1x100% - LRVP**
- **Holding duty: 3x100% (1x100% LRVP; 2x100% SJAE)**
- **Challenges:**
  - No auxiliary boiler in the plant, for this reason the SJAE must operate on main steam, the consumption of which affects the efficiency of the plant. Motive steam pressure and steam consumption is inversely proportional.
  - Consequently, the design motive steam pressure was set higher (16 bar) than the opening pressure of the bypass valves; this causes a gap, where the SJAE cannot yet function, but the ACC's is inoperable without a functioning holding air evacuation equipment.
- **Our solution:**
  - The LRVP steps in for the SJAE in the mentioned gap.
  - The inlet pressure of the LRVP is increased via an atmospheric air ejector to prevent cavitation.
  - Pressure Reduction Valve (PRV) station for the motive steam of the SJAE (40 bar →16 bar) designed by EGI.
  - Solution required close cooperation with the suppliers of the LRVP and SJAE units.



WARSAW WASTE TO ENERGY PROJECT

Measures against the threat of freezing in winter conditions

- **Plant is utilized for district heating in the winter**
  - Steam flow may be reduced to 15% of the design value, which means freezing danger becomes acute without proper measures
- **Two measures applied to decrease the heat rejection capacity and to avoid freezing**
  - Reduction of airflow – **VFD**
  - Reduction of surface area – **sectioning valves**



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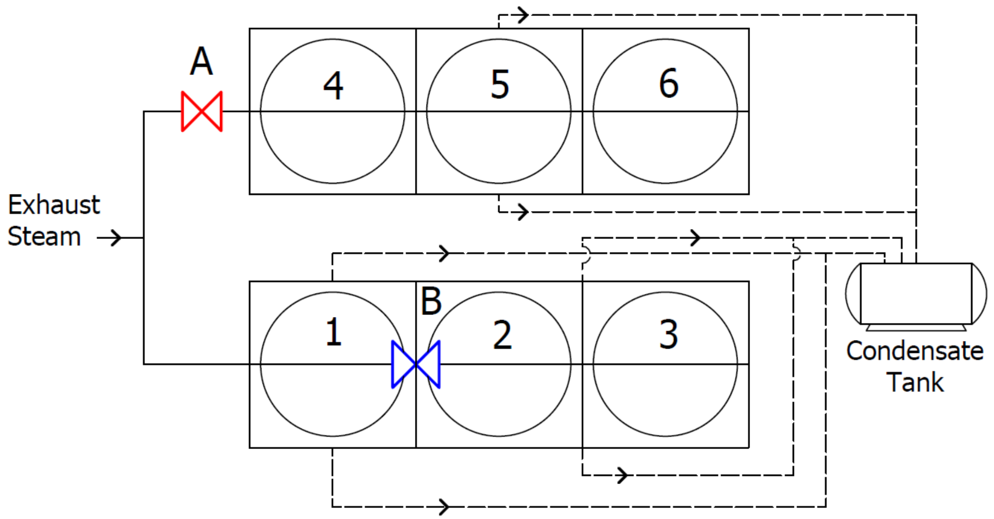
WARSAW WASTE TO ENERGY PROJECT

Sequence of measures against freezing



- **Input: pressure measurement close to the steam exhaust, with 3x pressure transmitter**
- **VFD is utilized in each fan**
- **Steps of the control sequence:**
  - **The steps follow each other in order of heat rejection capability, from highest to lowest**

1. Winter operation regime is activated under **+2°C**
2. The RPM of all fans are reduced to the minimum
3. Valve **A** is closed, fans #**4**, **5**, **6** are switched off and the RPM of fans #**1**, **2** & **3** are increased as necessary.
4. The RPM of fans #**1**, **2** & **3** are gradually decreased to the minimum
5. Fans #**1**, **2** & **3** are switched off
6. Valve **B** is closed and the RPM of fan #**1** is increased as necessary
7. The RPM of fan #**1** is gradually decreased to the minimum
8. Fan #**1** is switched off (valves **A** & **B** are closed and fans #**1-6** are switched off)
9. If the steam flow is reduced under the threshold value (**13,5 t/h**), the steam unit will trip.

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