SUSTAINABLE PLACES 2022

Design of a district heating/cooling plant coupled with waste-heat recovery from a data centre in a University Campus in Spain

PAOLO TADDEO , S. ESCUDERO, J. ROMANÍ, J. RONCAL CASANO, J. RODRÍGUEZ, I. GURRUCHAGA, A. IVANCIC, A. ABÁNADES, J. SALOM

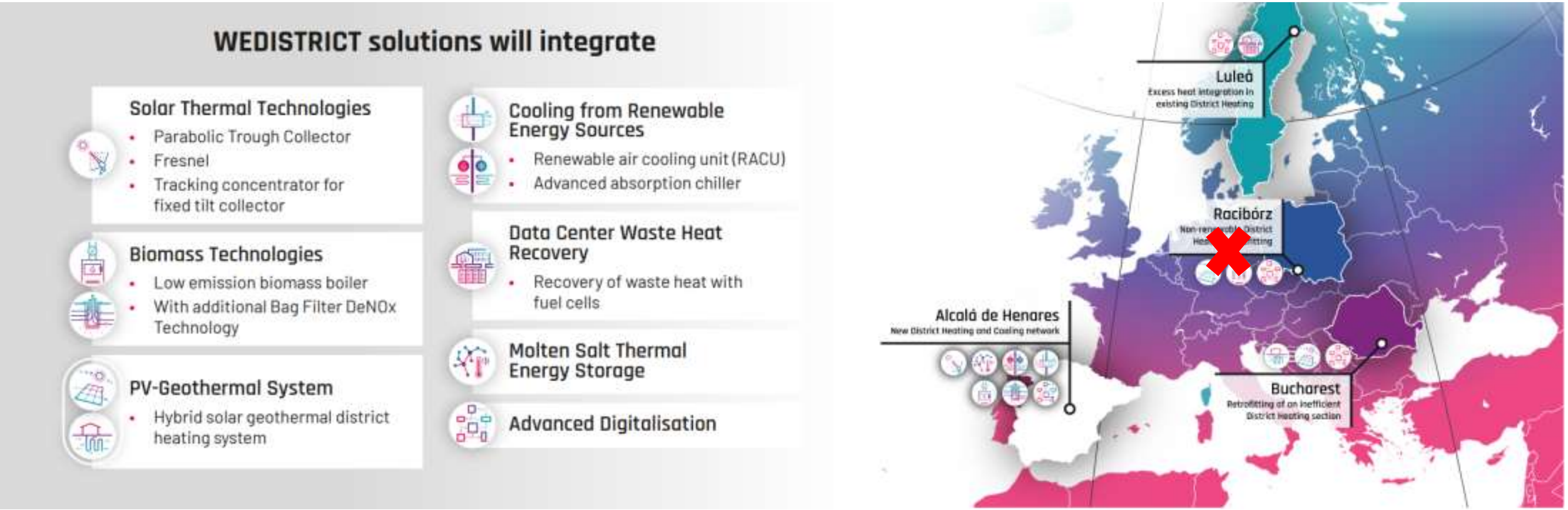
IREC Shaping Energy for a Sustainable Future

W.E. DISTRICT Heating & cooling solutions

POLITÉCNICA

WEDISTRICT PROJECT

In WEDISTRICT project, industry innovators from 9 European countries will integrate multiple sources of renewable energy and excess heat to showcase solutions for fossil free district heating and cooling systems being aligned with the foremost goal of the European Green Deal which is reaching climate-neutrality in 2050.



WEDISTRICT solutions will be implemented in three real-scale projects in Spain, Romania and Sweden. **As part of the project, other virtual demo sites have been set-up. These virtual demo sites are based on new or existing DHC system wishing to test improvements based on WEDISTRICT concepts (e.g: RES, waste heat recovery (WHR) solution).**

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement N°857801

MONTEGANCEDO CAMPUS

The Montegancedo Campus is a recent development campus belonging to the Polytechnic University of Madrid (UPM). It is located in Pozuelo de Alarcon (Madrid, Spain) and it occupies 480.000 m2

Super computing center (CESVIMA)

- **Air - cooled data center**
- **IT power = 60 kW**

Biotechnology and plant genomics research center (CBGP)

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METHODOLOGY

Data acquisition and analysis → Presencial visit to the installation and data collected from real electricity and gas bills

Hourly demand profiles generation → Detailed hourly demand profiles generated from monthly data

Plant modelling → Detailed plant modelling in TRNSYS environment using WEDISTRICT solutions

Plant sizing optimization → Extensive parametric analysis on main sizing parameters in order to find the best enviromental/economical layout

Data center waste heat recovery → Data center modelling to investigate heat recovery potential

KPIs evaluation → Results comparison with key performance indicators formulated for WEDISTRICT project

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DHC plant modelling

M120: Solar parabolic trough field

M310 / M310_2: Biomass / Nat. gas boilers

M210 / M210_2: Thermal storages

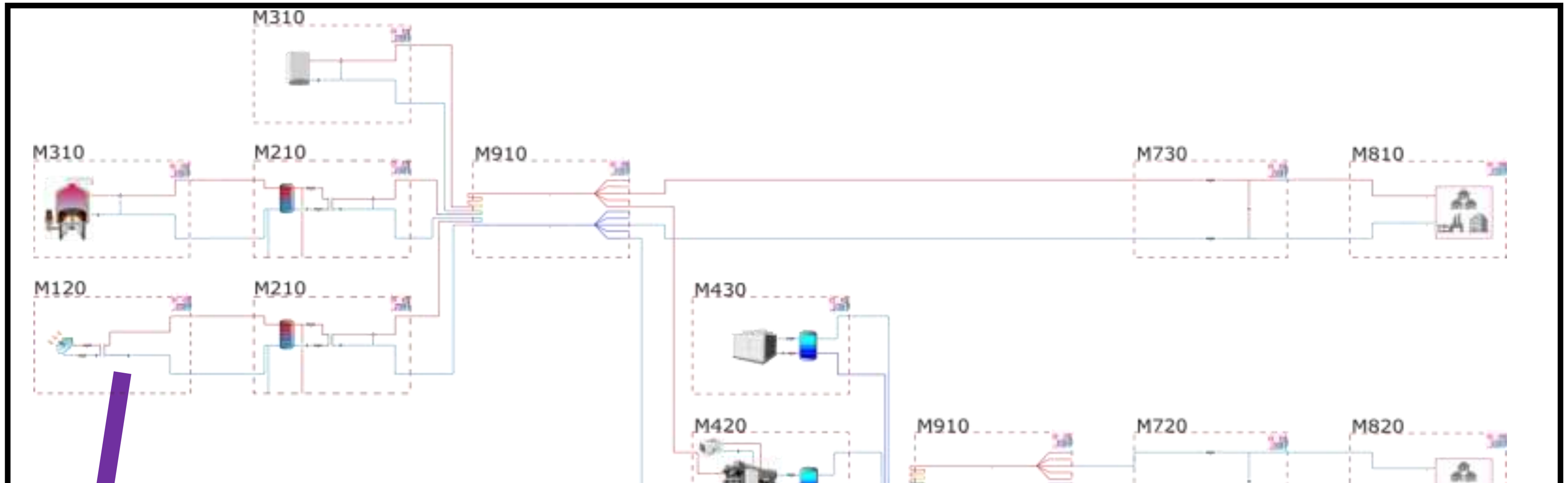
M420: Abs. Chiller

M431: Conv. Chiller

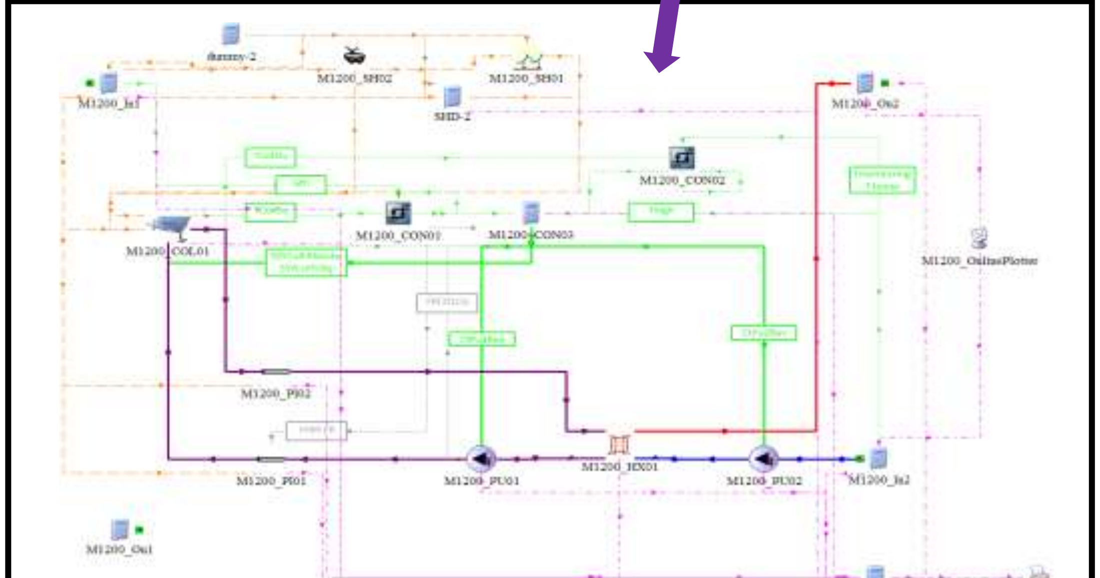
M730: Heating dist. Network

M720: Cooling dist. Network

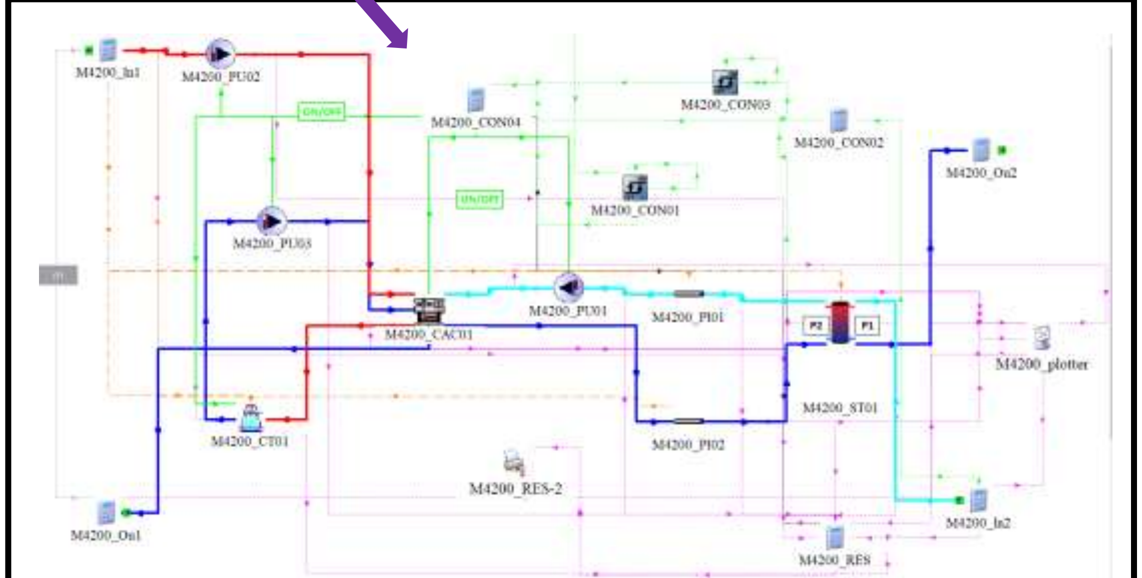
M810/820: Heating and cooling demands



TRNSYS translation



M120: Solar collector field



M420: Single stage absorption chiller

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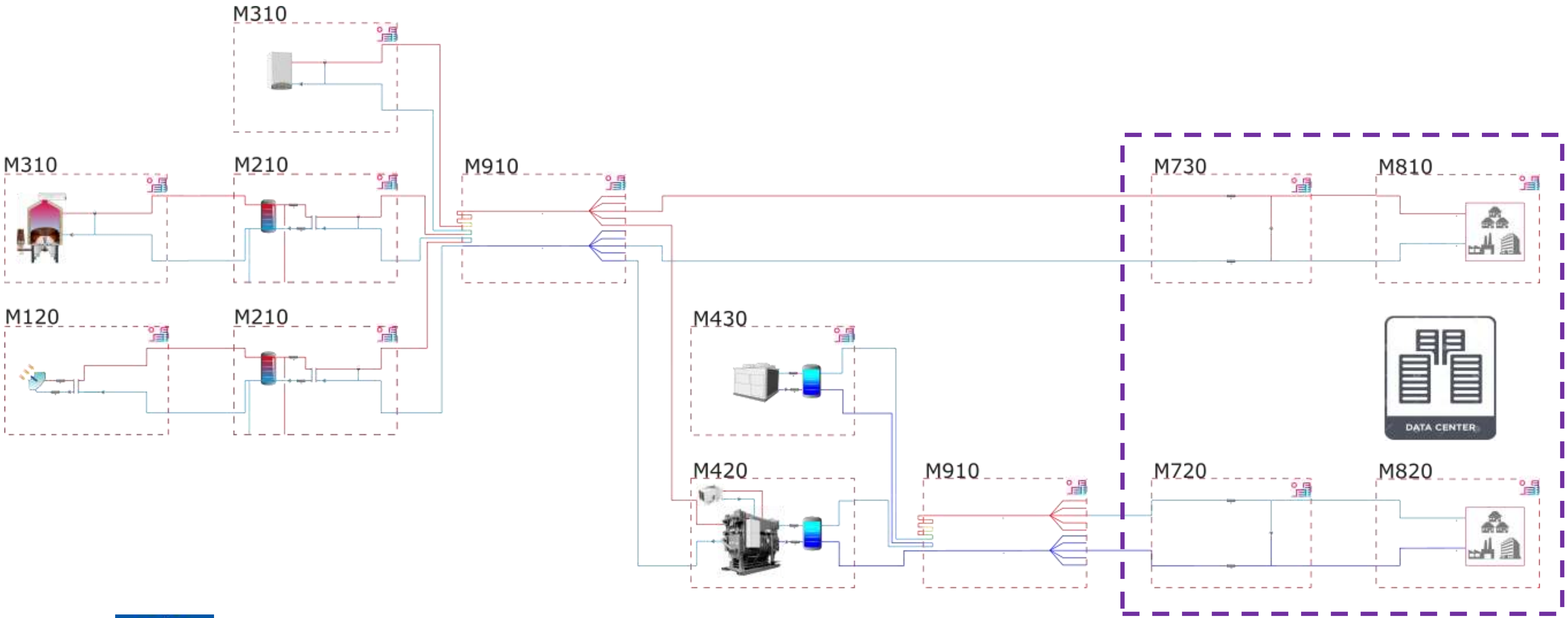
Demand scenarios simulated

<u>1) Data centre NOT connected to the district cooling network</u>

2) Data centre connected to the district cooling network

3) Data centre NOT connected to the district cooling network with WHR solution connected to district heating network



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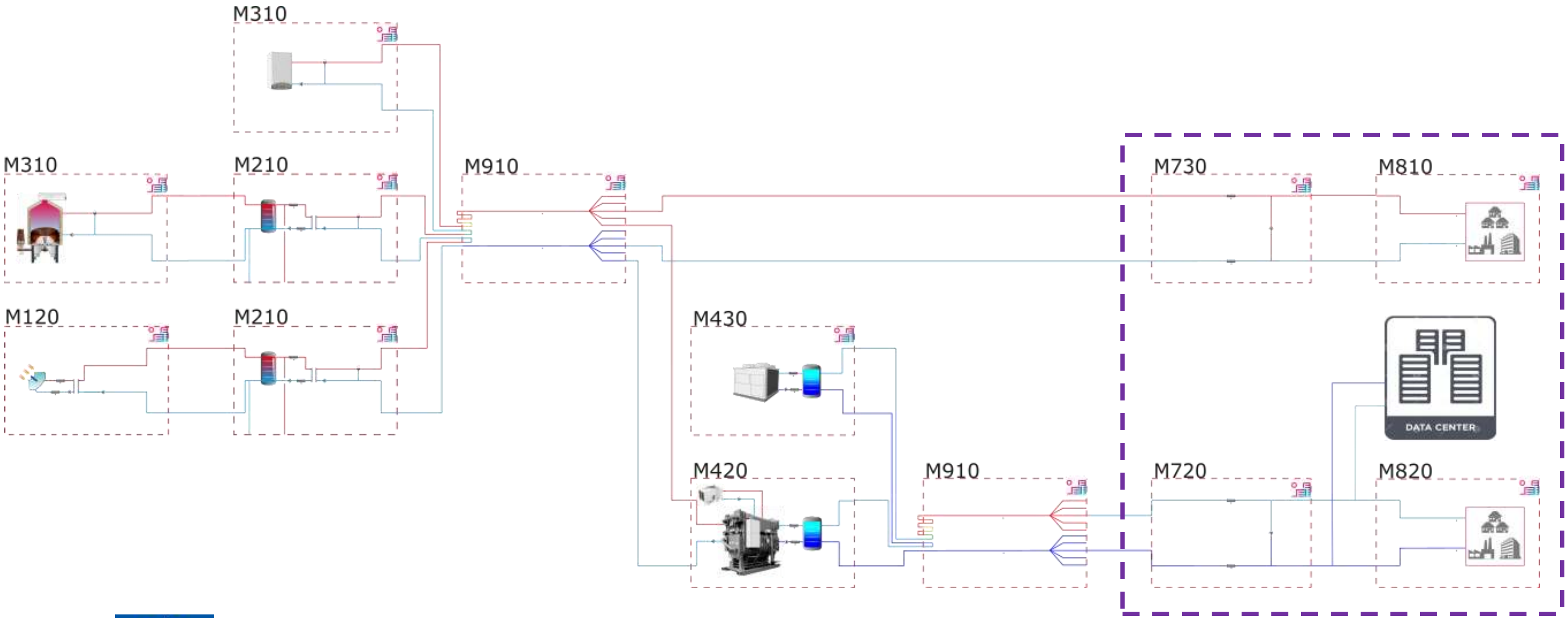

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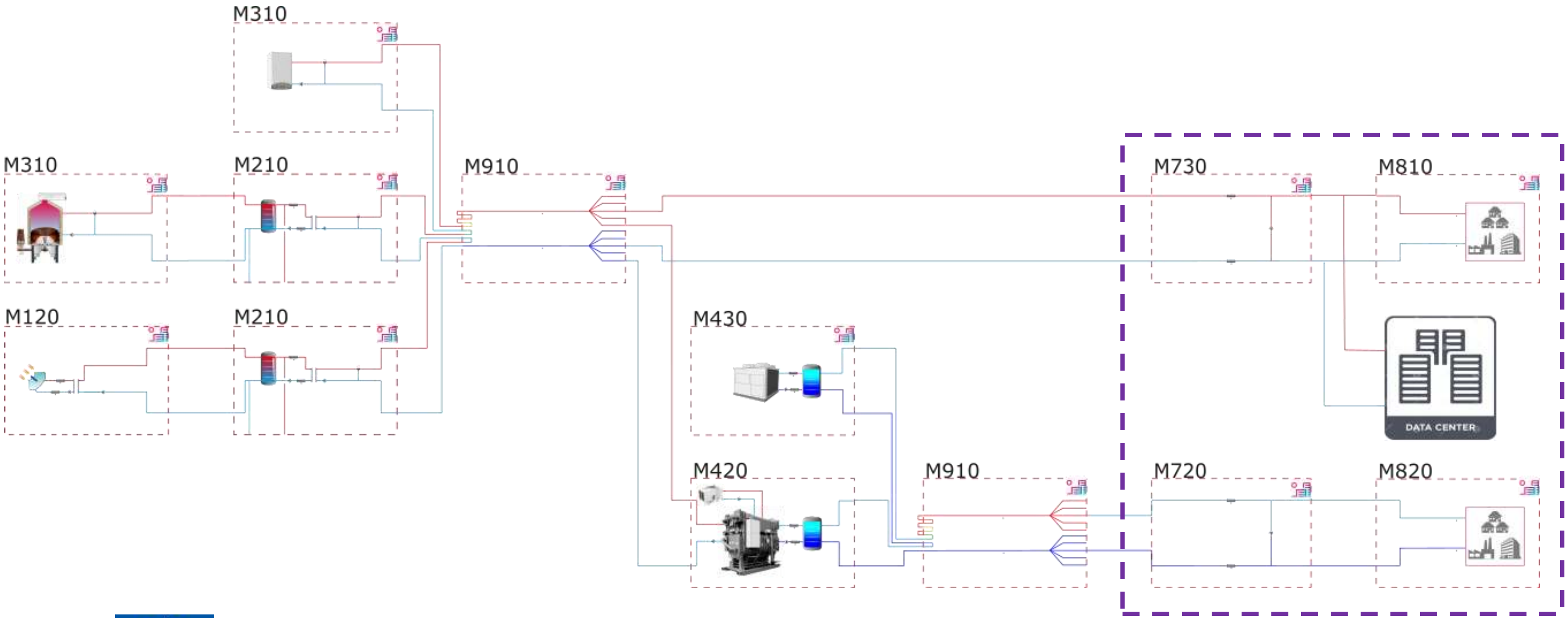

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Cases simulated (yearly simulations)

Cooling peak = 3 MW

Heating peak = 4 MW

Parametric analysis on main equipment capacities, values considered:

- Solar collector area**: [100:2100:4100:6100] m2**
- Solar thermal storage volume**: [150:350] m3**
- Biomass boiler heating power capacity**: [1000:1900:2800:3700] kW**
- Biomass boiler thermal storage**: [150:300:450] m3**
- Natural gas boiler heating power capacity**: [Heating peak - Biomass boiler power capacity] kW**
- Abs. chiller cooling power capacity**: [100:500:1000:1500] kW**
- Compression chiller cooling power capacity**: [Cooling peak - Abs. chiller cooling power capacity] kW**
- Cooling storage volume**: [150:350] m3**

768 cases for each demand scenario

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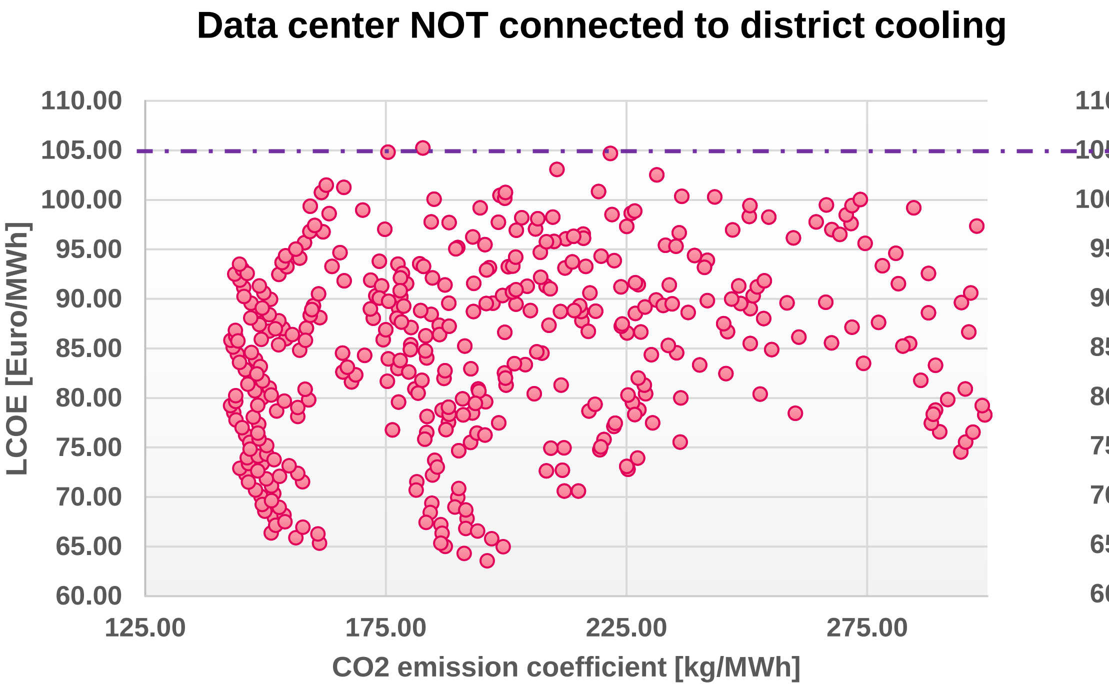
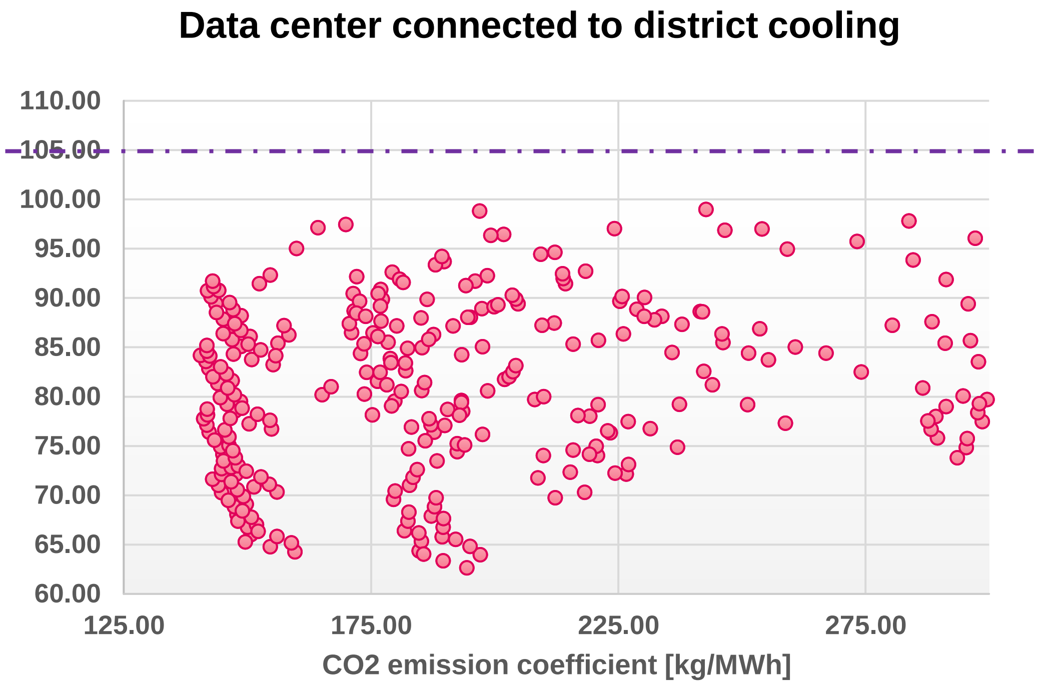
Parametric analysis results:





Results:

1) Pareto optimality where there's no unique "optimum" solution.

2) When the data center is connected to the district cooling the plant increases the hours of operation. This reflects in equipment working at higher partial loads with better performance.

3) Optimized results do not differ between them in a major way. Equipment work at nominal conditions.

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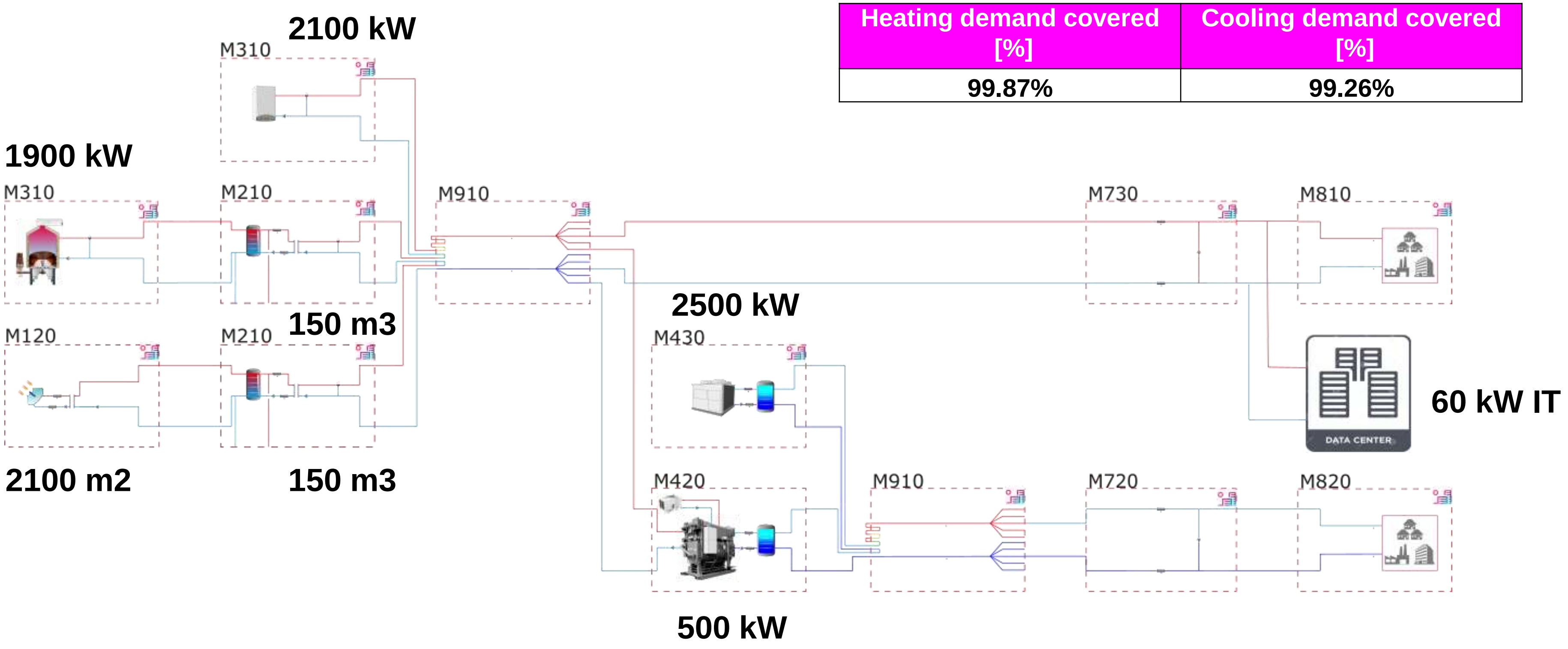
Scenario selected to investigate WHR solution

Heating demand covered [%]	Cooling demand covered [%]
99.87%	99.26%



Renewable energy ratio for the selected scenario

Heating renewable energy ratio [-]	Cooling renewable energy ratio [-]
0.33	0.26

Renewable energy ratio for the real site

Heating renewable energy ratio [-]	Cooling renewable energy ratio [-]
0.02	0.17

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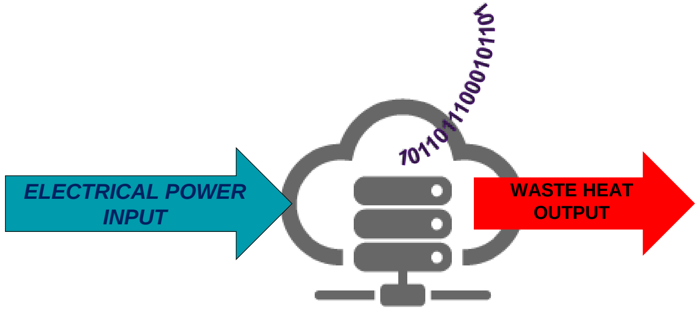
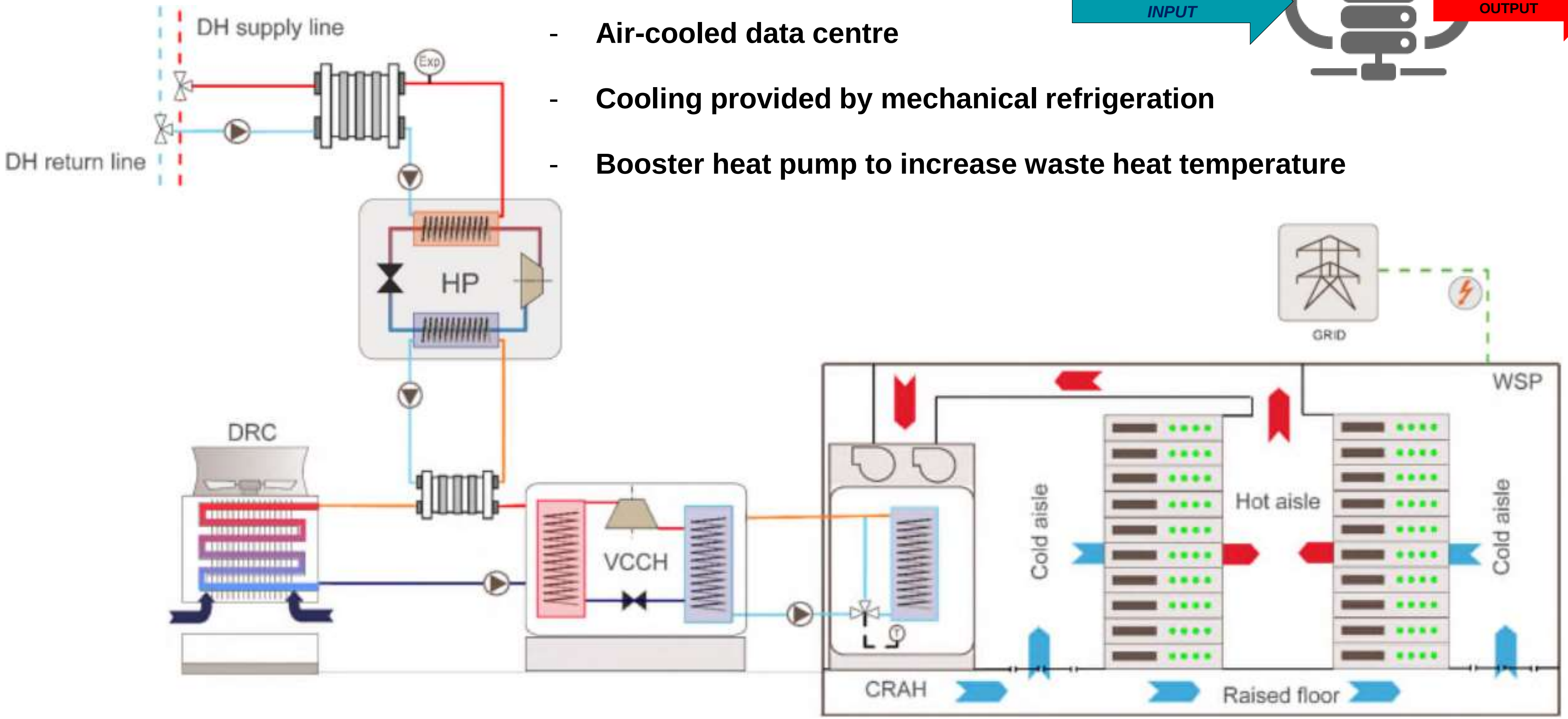
Data centre waste heat recovery solution



- Air-cooled data centre
- Cooling provided by mechanical refrigeration
- Booster heat pump to increase waste heat temperature



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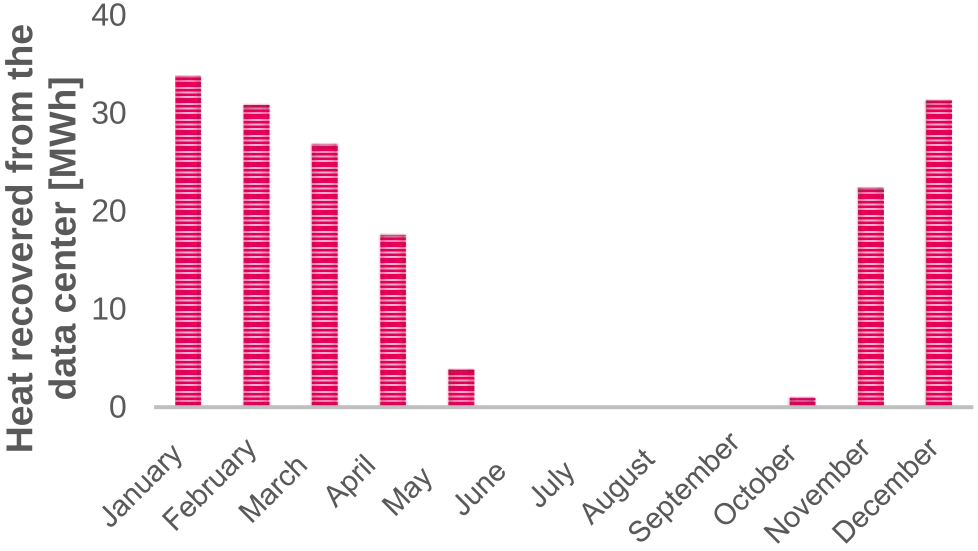
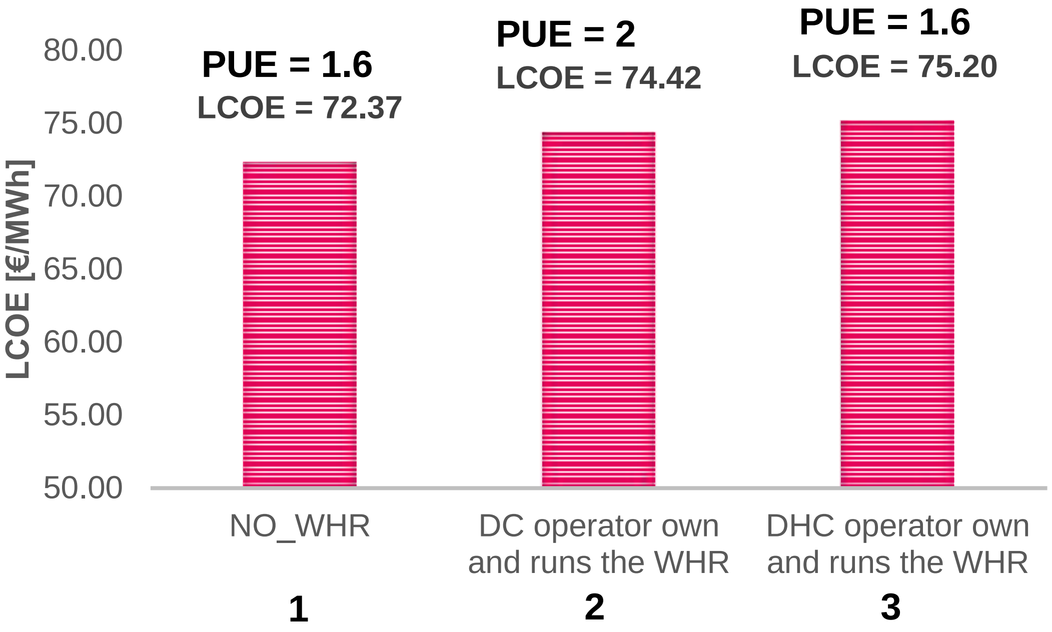
Waste heat recovery results and discussion

Power Usage Effectiveness (PUE) = $\frac{Total\ Data\ Center\ consumption}{Information\ Equipment\ consumption}$





- **Waste heat recovery help reducing the heating demand of the DHC plant but, in order to achieve economical feasibility, the WHR solution should be contemplated since the design process.**

- **It is the DHC operator that owns and runs the WHR system or it is the DC owner?**

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Achievements

- **A district heating and cooling plant has been modelled and optimized using dynamic simulations in order to provide useful guidelines for a real site implementation in a University Campus.**
- **Data center waste heat recovery has been investigated by means of a detailed air-cooled data center model coupled by a temperature booster heat pump.**
- **WEDISTRICT simulation environment working and representing a powerful and flexible tool to simulate different district heating and cooling solutions.**

Overall conclusions

- **Results show that the solution proposed is able to cover the entire University Campus demand and increasing the share of renewable energy.**
- **A deep analysis on the waste heat recovery potential should be performed during the plant design process to investigate it's integration and synergies with the central plant. This is needed to avoid equipment oversizing and redundancies (that enhance CAPEX costs) .**

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Any questions?

Corresponding mails:

Joaquim Romaní Picas: **jromani@irec.cat**

Paolo Taddeo: **ptaddeo@irec.cat**

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