III International Scientific Conference **“Sustainable and efficient use of energy, water and natural resources – SEWAN-2021”**

Title: Analysis of the heat recovery potential in the classroom

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Saint-Petersburg, April 19-24, 2021

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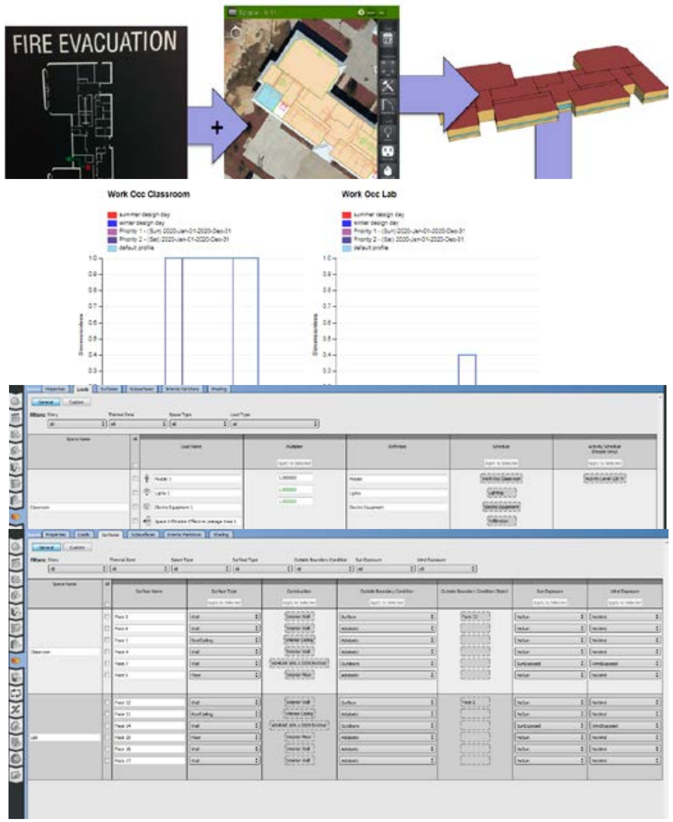
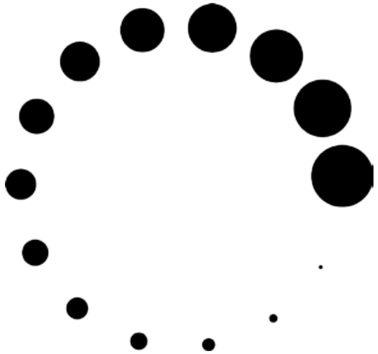
Keywords:
Energy modeling, heat recovery, EnergyPlus

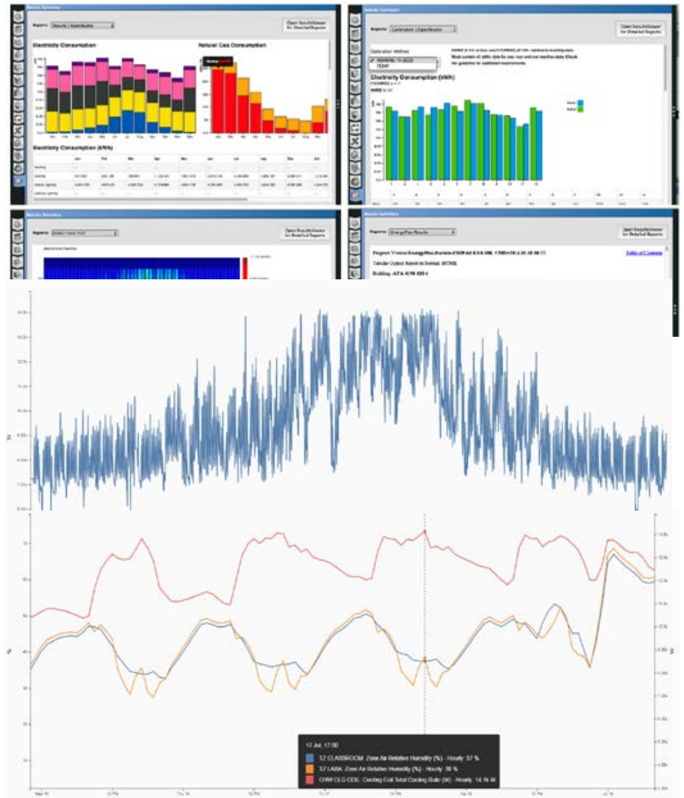
Energy Plus Software



Data Input



Data Processing



Results

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Stockholm Central Station

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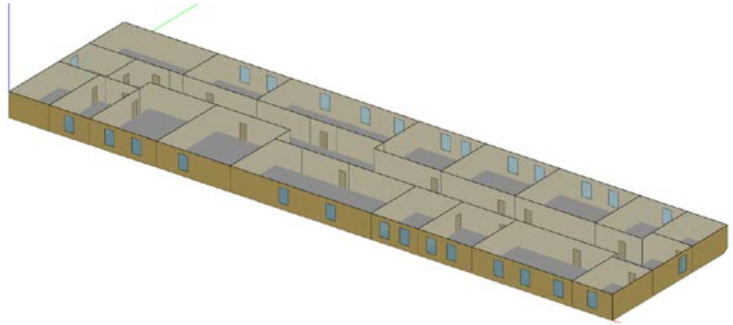
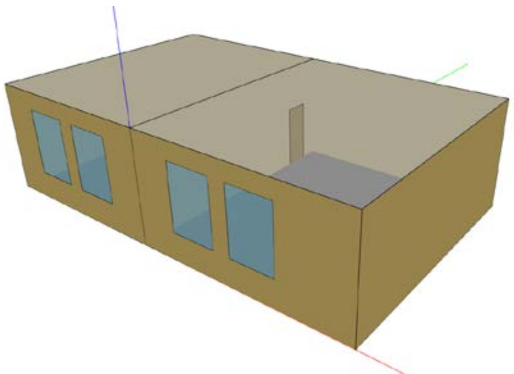
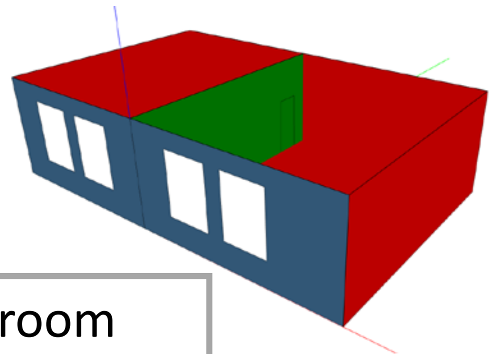
Designed model

The 2nd floor of one of the buildings of ITMO University



The Daikin laboratory





The classroom 4212

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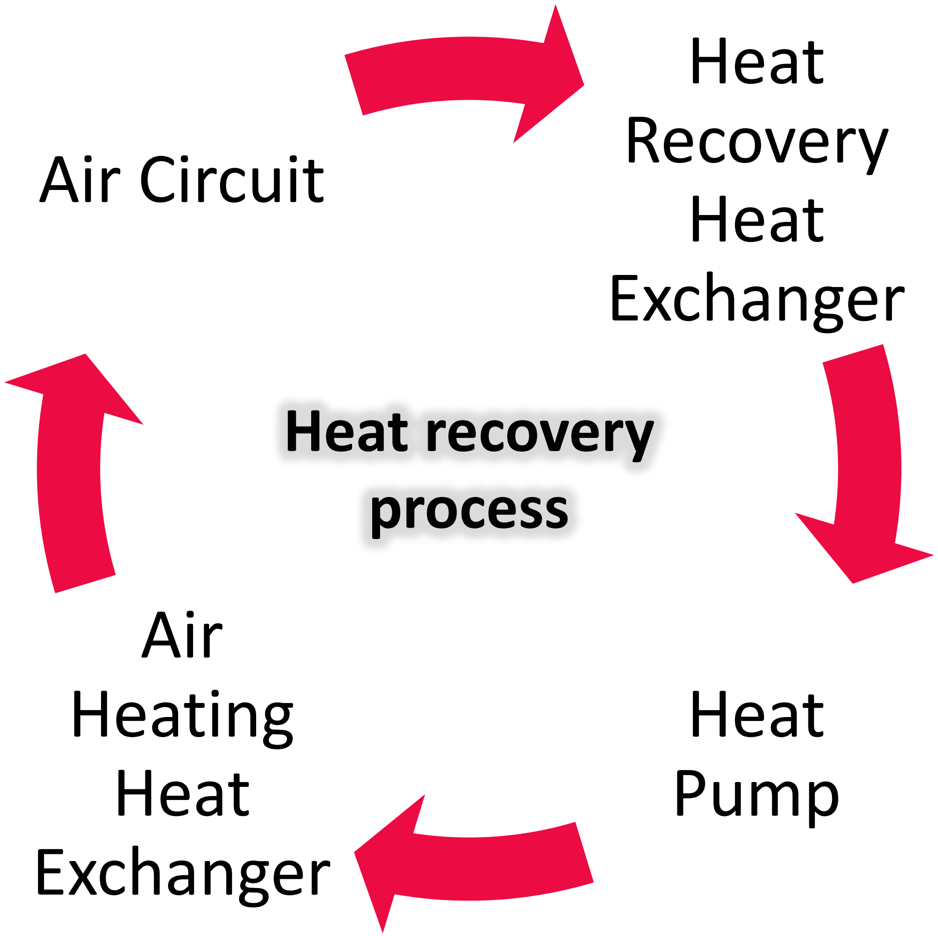
Research Objective – Heat recovery



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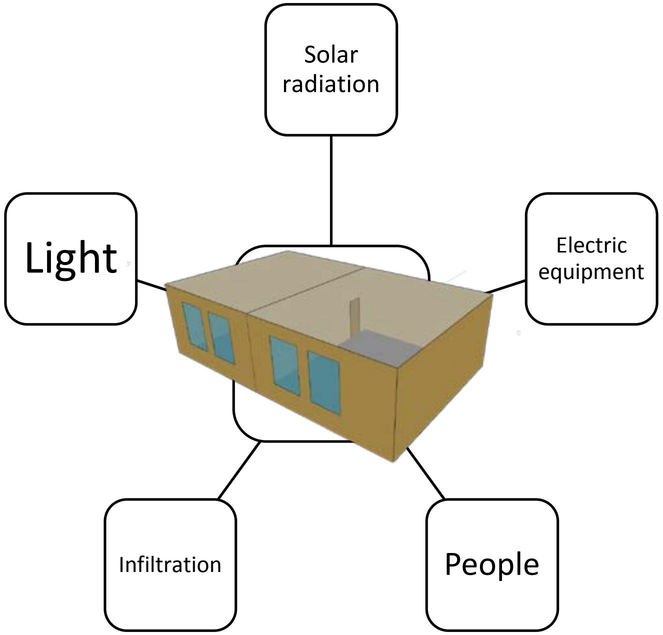
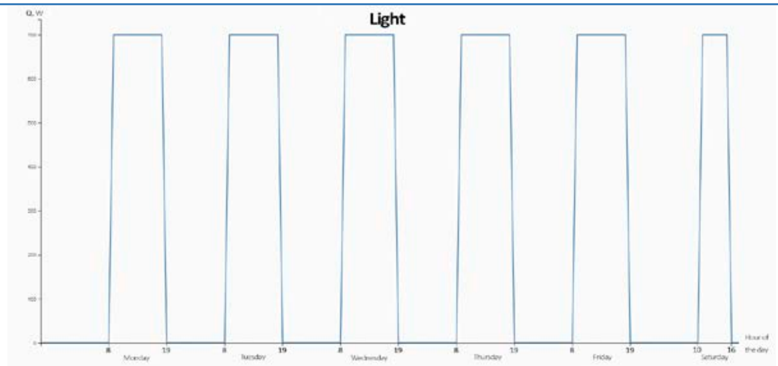
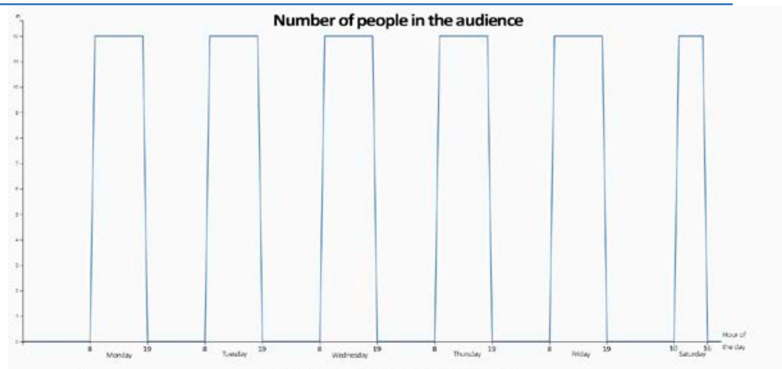
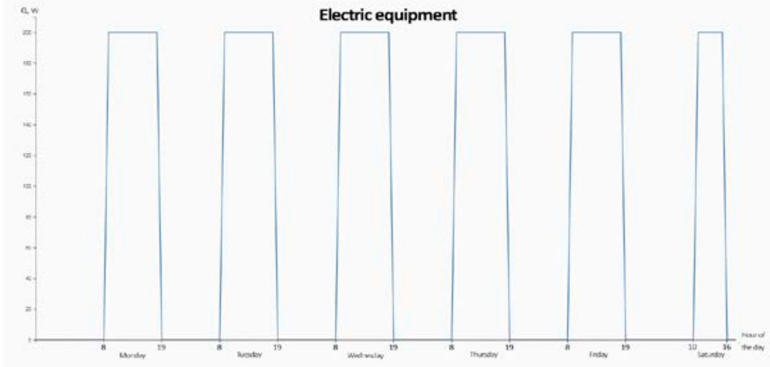
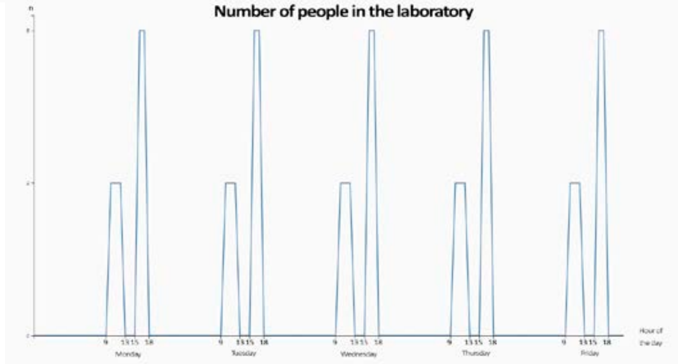










Inside Heat Balance:

$$q''_{LWX} + q''_{SW} + q''_{LWS} + q''_{ki} + q''_{sol} + q''_{conv} = 0$$

where:

q''_{LWX} – net longwave radiant exchange flux between zone surfaces;

q''_{SW} – net shortwave radiation flux to surface from lights;

q''_{LWS} – longwave radiation flux from equipment in zone;

q''_{ki} – conduction flux through the wall;

q''_{sol} – transmitted solar radiation flux absorbed at surface;

q''_{conv} – convective heat flux to zone air.

Infiltration by Effective Leakage Area:

$$Infiltration = (F_{Schedule}) \frac{A_L}{1000} \sqrt{C_s \Delta T + C_w (WindSpeed)^2}$$

where:

$F_{Schedule}$ – a value from a user-defined schedule;

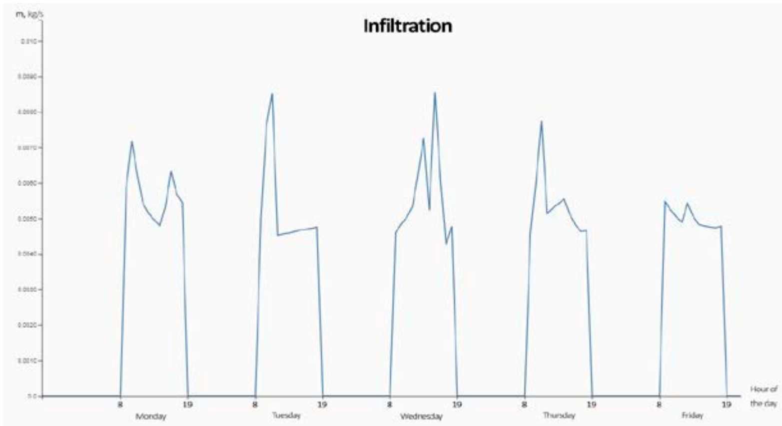
A_L – the effective air leakage area in cm that corresponds to a 4 Pa pressure differential;

C_s – the coefficient for stack-induced infiltration in $(L/s)^2 / (cm^4 \cdot K)$;

ΔT – the absolute temperature difference between zone air and outdoor air;

C_w – the coefficient for wind-induced infiltration in $(L/s)^2 / (cm^4 \cdot (m/s)^2)$;

$WindSpeed$ – the local wind speed.



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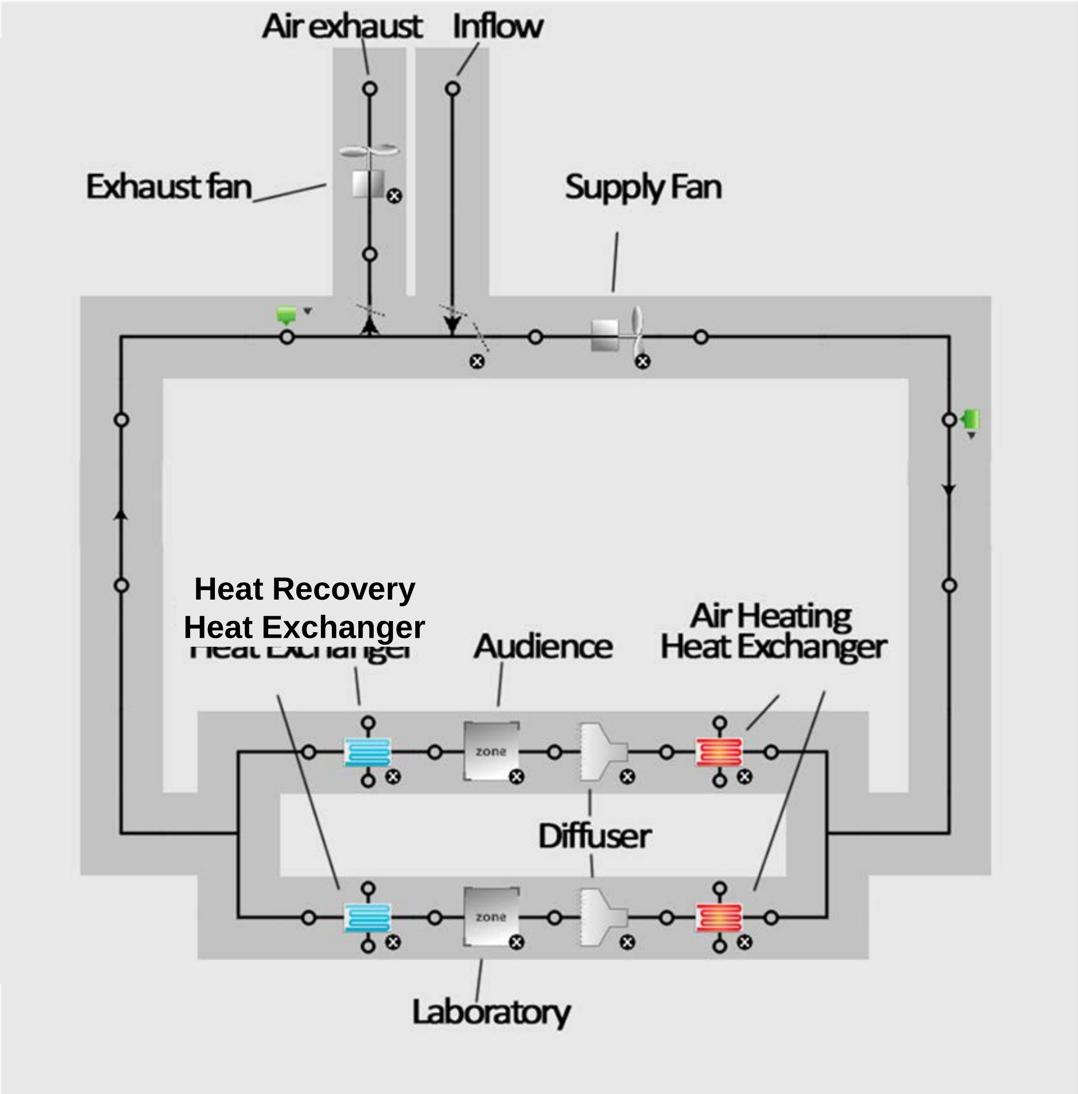

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Calculation of heat recovery heat exchanger rate:

$$Q_{total} = (m_{supply})(h_{outlet} - h_{inlet})$$

$$Q_{sensible} = (m_{supply})(h_{outlet} - h_{inlet})HR_{min}$$

$$Q_{latent} = Q_{total} - Q_{sensible}$$

where:

Q_{total} – total energy transfer rate by the system;

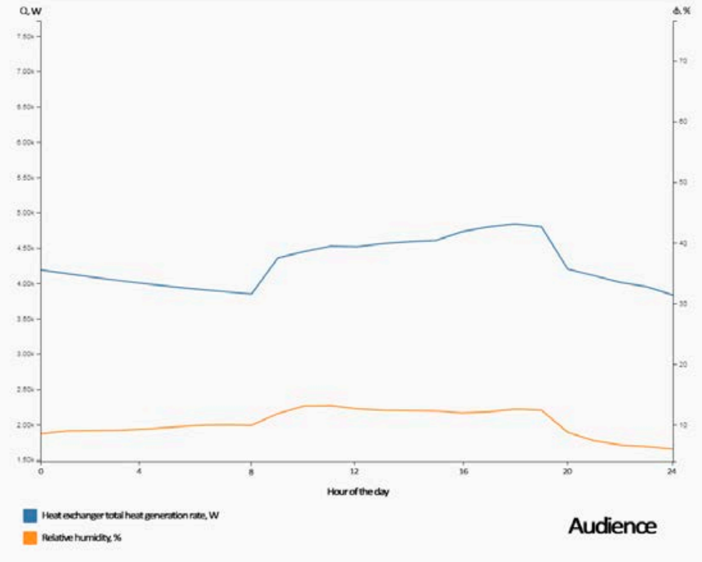
$Q_{sensible}$ – sensible energy transfer rate by the system;

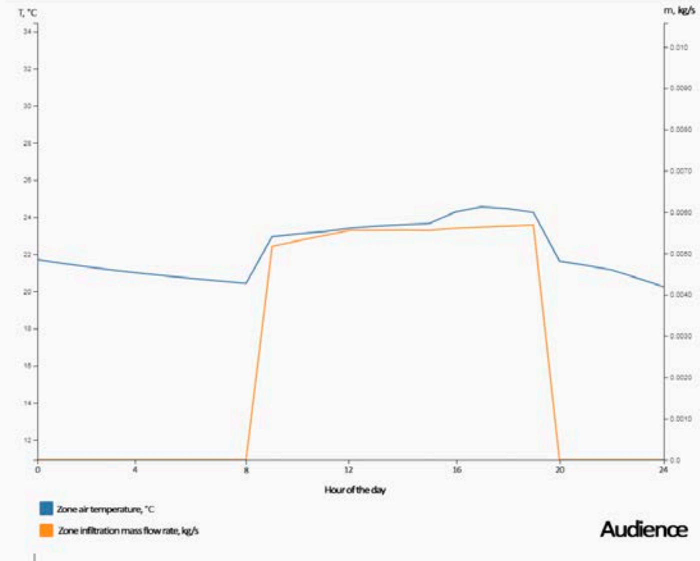
Q_{latent} – latent energy transfer rate by the system;

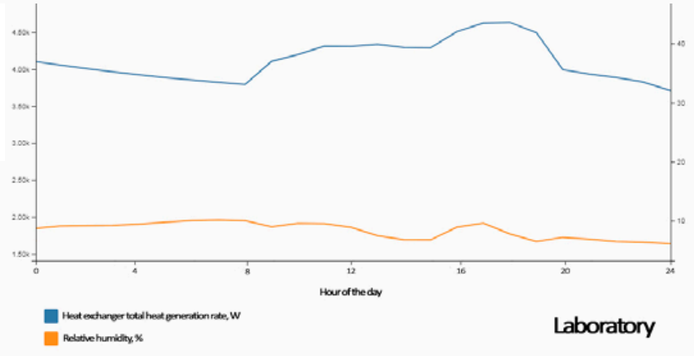
h_{inlet} – enthalpy of the air entering the unit at its inlet node;

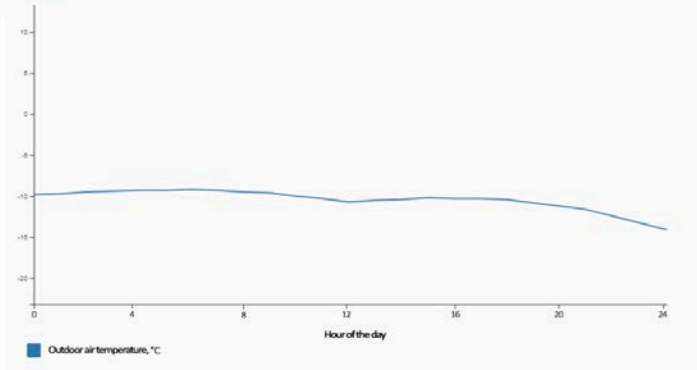
h_{outlet} – enthalpy of the air leaving the unit at its outlet node;

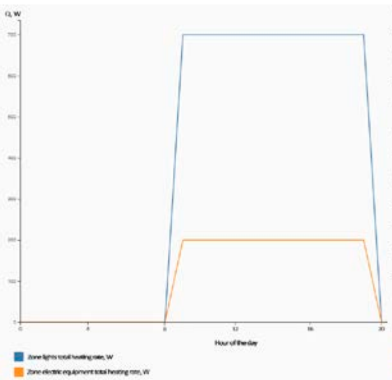
HR_{min} – minimum of the inlet air and outlet air humidity ratio.

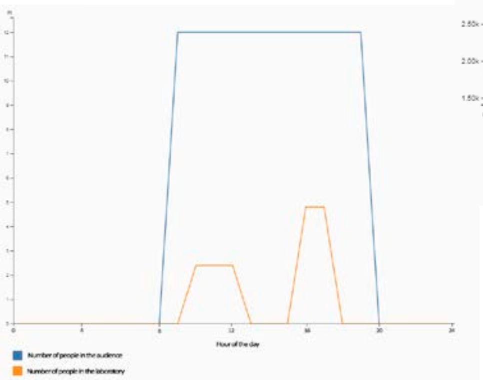












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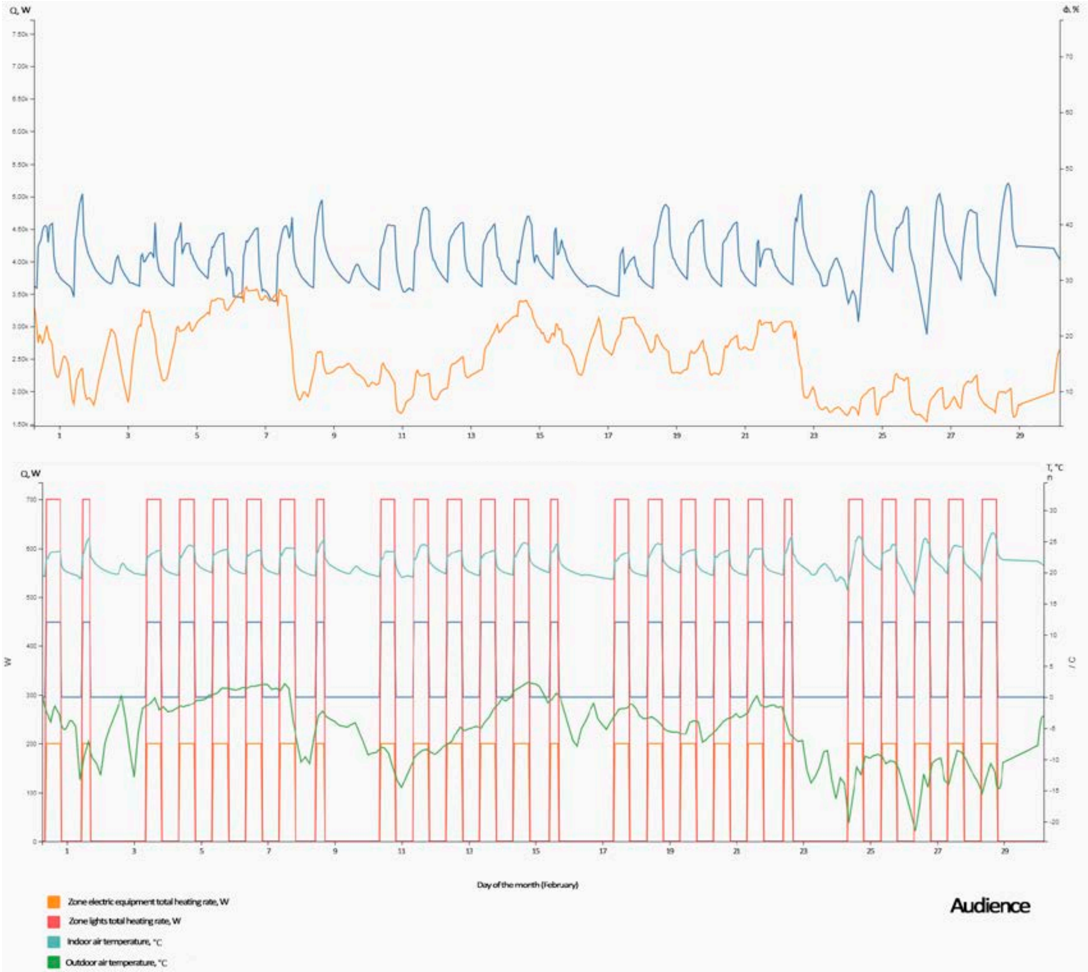
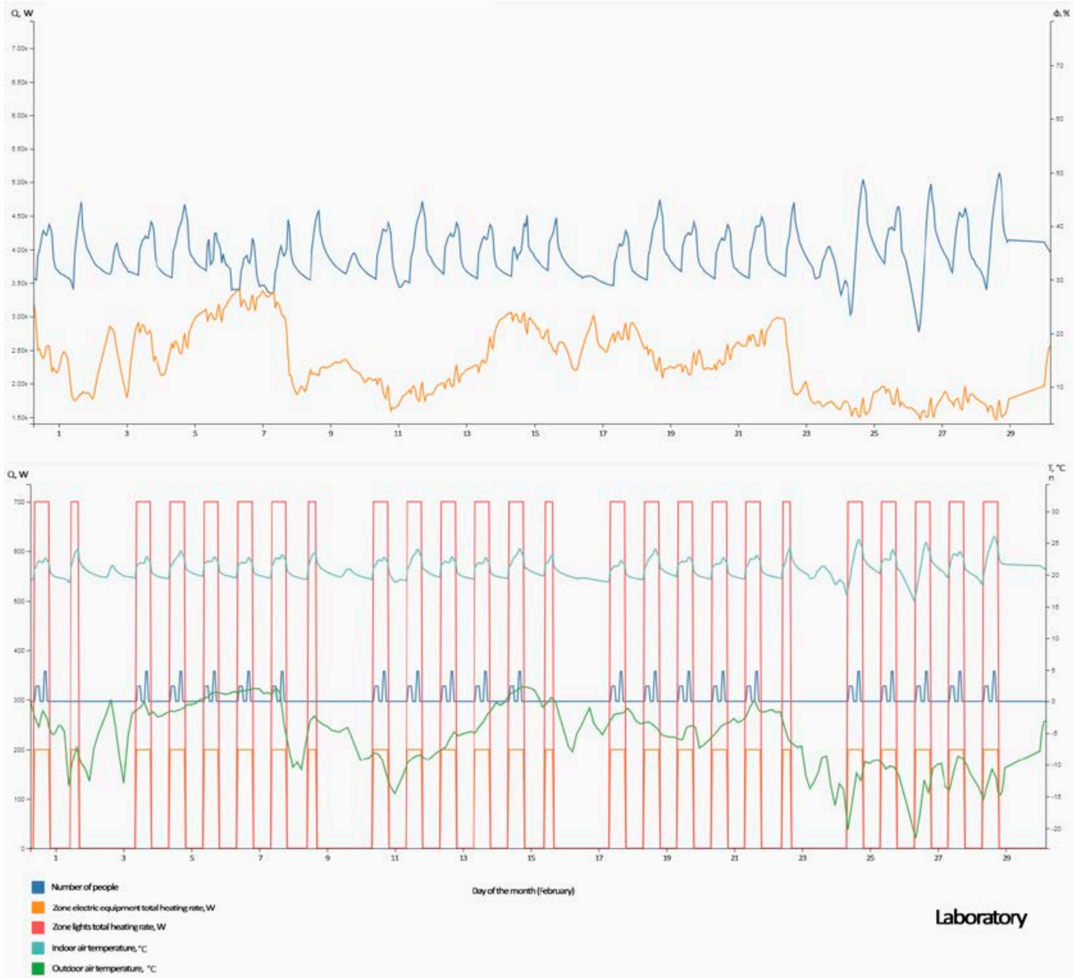
Heat recovery heat exchanger rate in month





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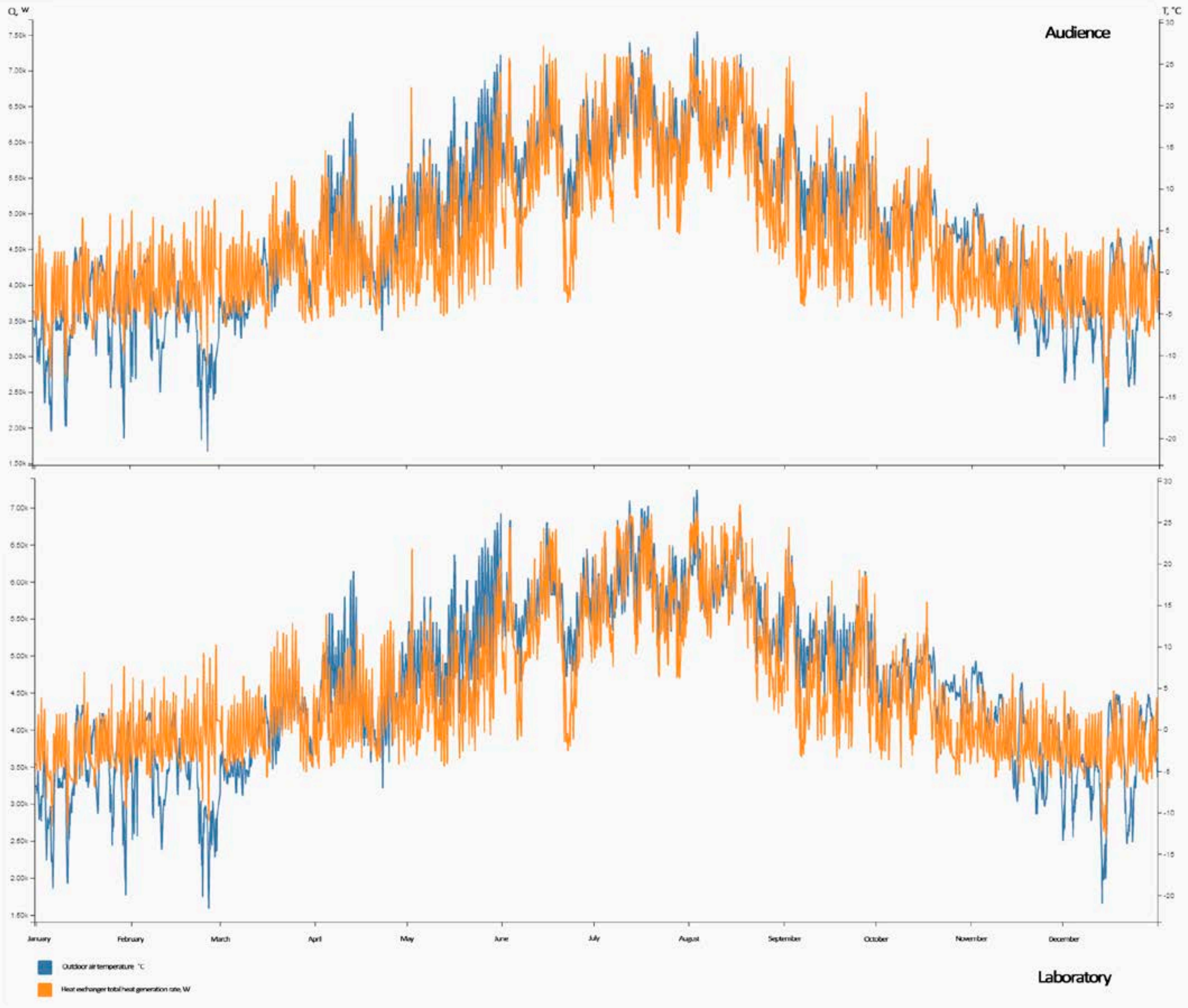
Heat recovery heat exchanger rate in year



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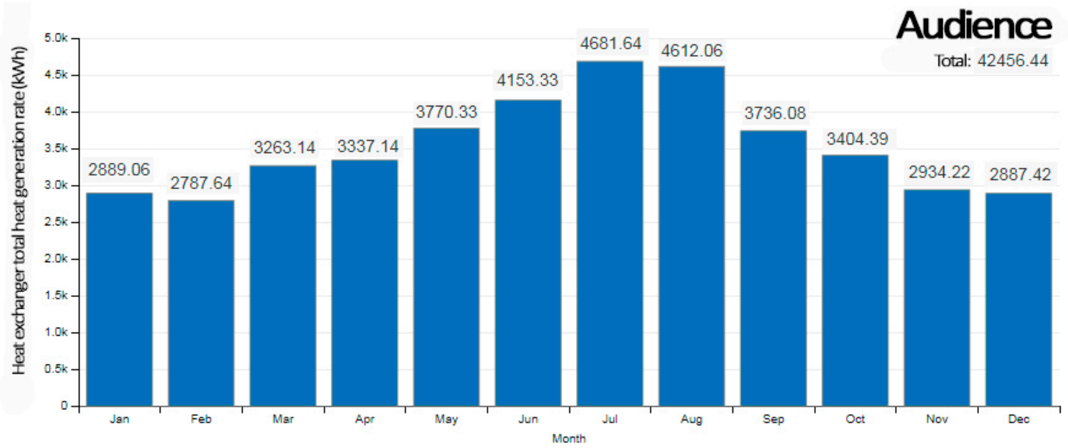

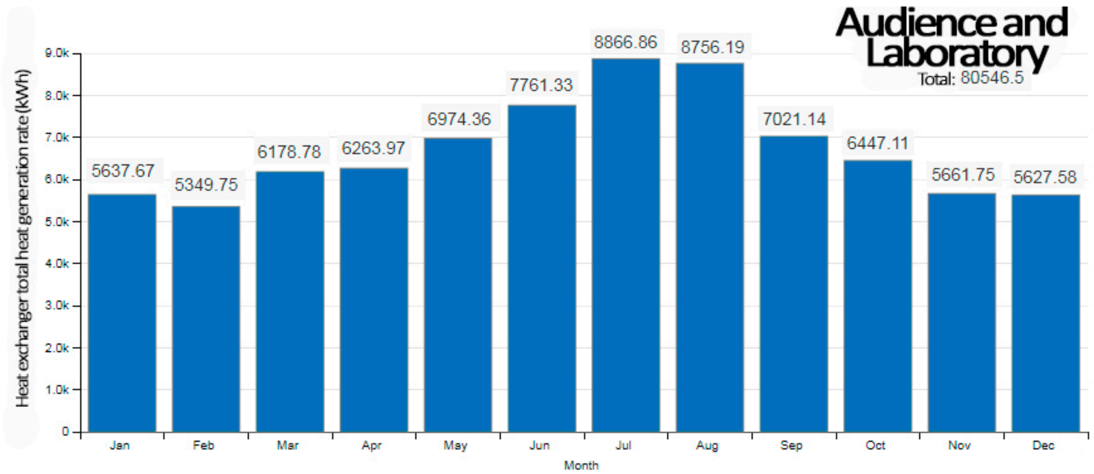

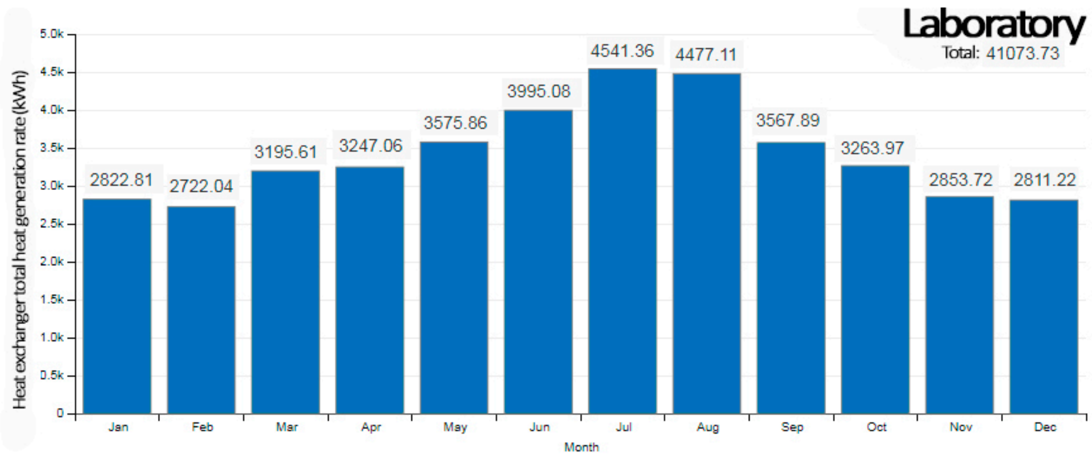

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Results

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Conclusions

It has been established that the relative humidity in the audience is most often equal to 10 to 40% per year. At this point of relative humidity, the instantaneous power of the heat recovery heat exchanger is between 3,500 and 5,000 W;

The diagram shows that the relative humidity in the room increased from 10% to 13% in one day, as a result instant power increased from 4,000 to 4,500 W. It means that the increase of relative humidity by 3% leads to an increase in power by 12.5%;

Based on the visualization graphs in a year, it is possible to note the conection between the change in outdoor temperature and relative humidity in the room. With a decrease of the outdoor temperature, the capacity of the air heater increases, the supply air heats up to the required temperature, as the result this leads to its dehumidification;

EnergyPlus software allows to efficiently carry out calculations and simulate various systems and conditions.

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Thank you for your attention!

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