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Project EMS-ENI, code 2SOFT/3.1/54

"Improving the cross-border public transportation using electric buses supplied with renewable energy (ELBUS)"

"Îmbunătățirea transportului public de frontieră folosind autobuze electrice alimentate cu energie regenerabilă" (ELBUS)"

Tabloul termic al electrobuzului și metode de reducere a pierderilor de energie

Marcel Burduniuc,
cercetător proiect ELBUS

Chișinău-Workshop, 28 - 29.03.2022

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Purpose of research

- Analysis of the auxiliary loads
- Thermal map of the electric bus
- Methods to reduce energy losses

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Activity 3.2. Analysis of the auxiliary loads.

The auxiliary systems comprise the electrical equipment of the vehicle which is not directly used in the generation of traction force. The following elements can be included in auxiliary systems:

- compressor and hydraulic pump motors
- supply of low voltage equipment
- air conditioning
- heating

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Activity 3.2. Analysis of the auxiliary loads.

Table 1 The range of nominal power of the main auxiliaries systems in 12 m electric bus or trolleybus.

System	Nominal power
Lightning	1-2 kW
Passenger information systems, ticket vending machine	1-3 kW
Charging of 24 V board batteries	0,5 - 2 kW
Air compressor	3-6 kW
Hydraulic pump	2-4 kW
Air condition	10-16 kW
Heating	5-25 kW

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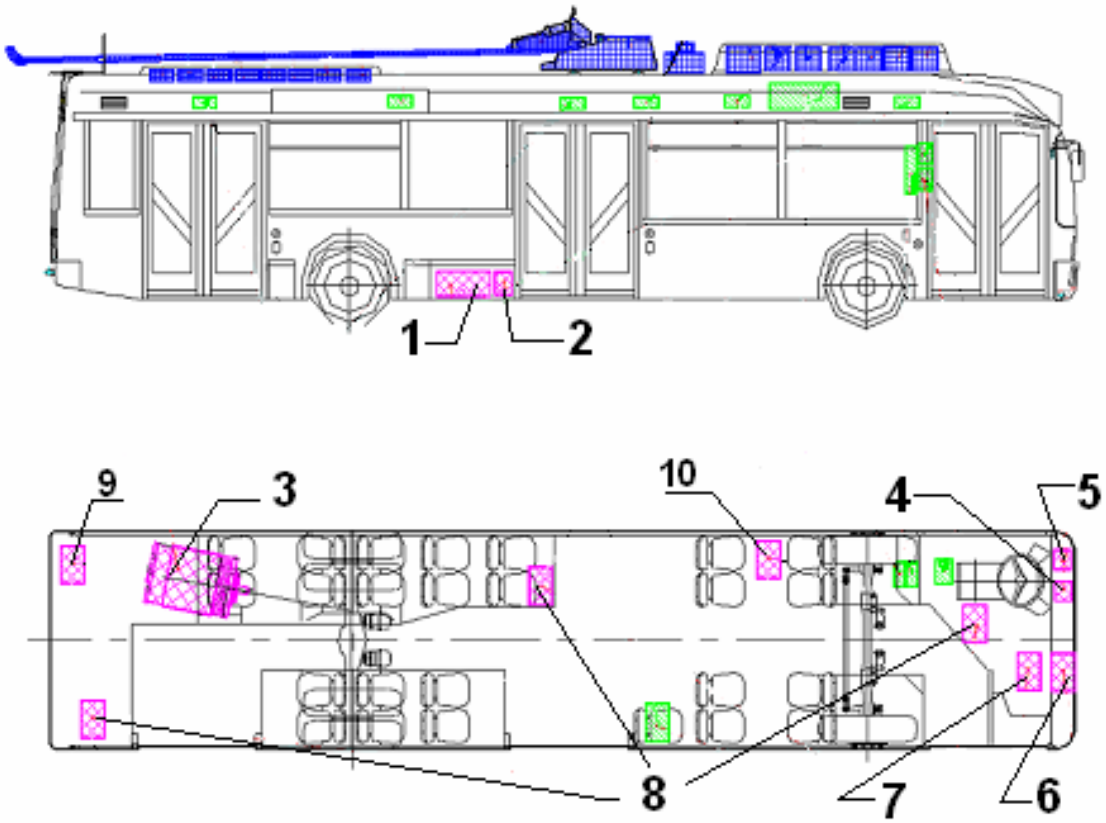
Activity 3.2. Analysis of the auxiliary loads.

Electrical equipment under the ebus floor



1	Batteries
2	Battery contactor block (BKAB) - A24, Charge limitation unit (BOZ) - A23
3	Electric motor DK-211
4	Travel controller - A36
5	Brake controller - A37
6	Heating block - A12 (AKCM32102-420100.000)
7	Driver's cab kiln fan
8	Electric air heater units - A13, A14, A15, A16 (AKCM321-410400.000) [11]
9	Compressor installation
10	Power steering motor

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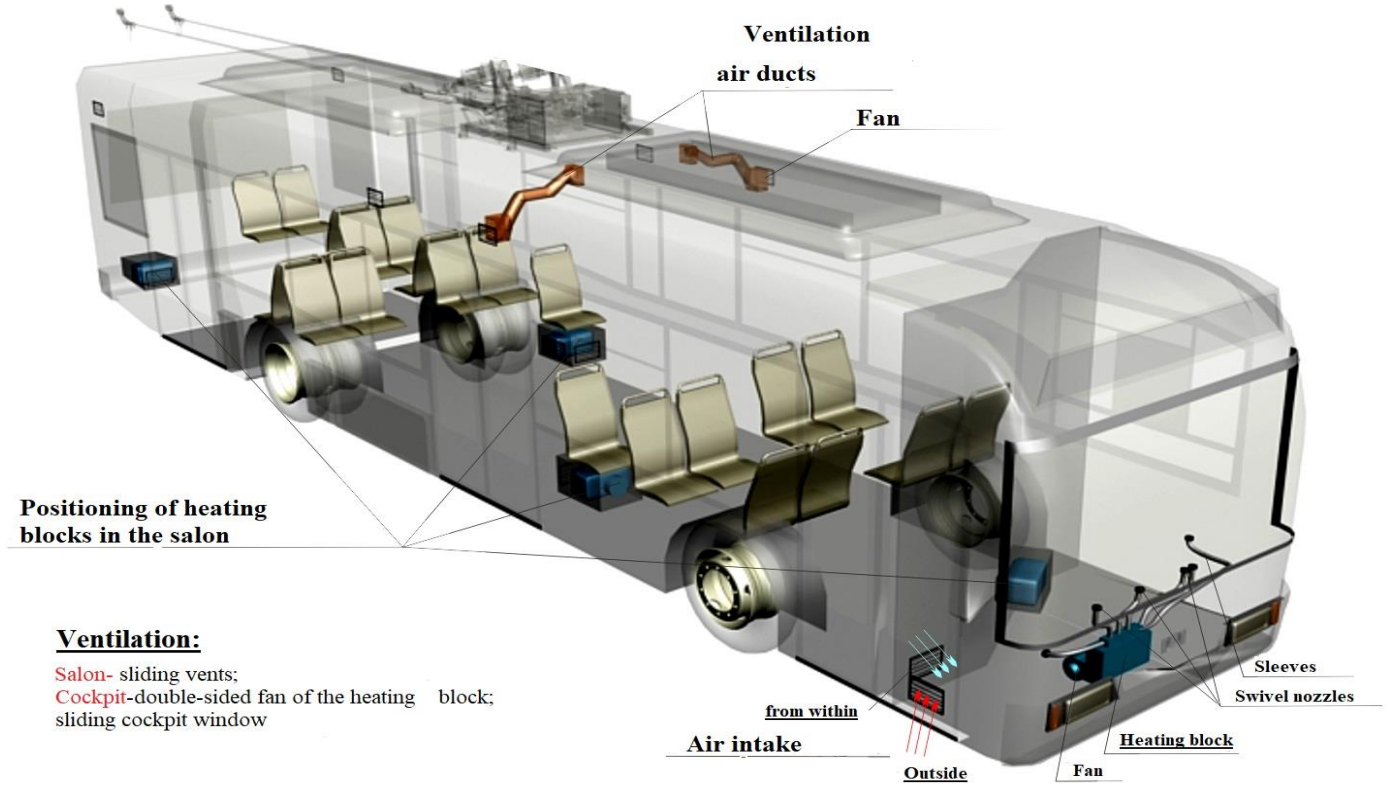
Activity 3.2. Analysis of the auxiliary loads.

The E321 BUS heating and ventilation system



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Activity 3.2. Analysis of the auxiliary loads.

Power of heating system

Nr .	Equipment destination	Rated power, kW	Nr. unit	Total power, kW
1	Cabin heating	9	1	9
2	Saloon heating	6	4	24

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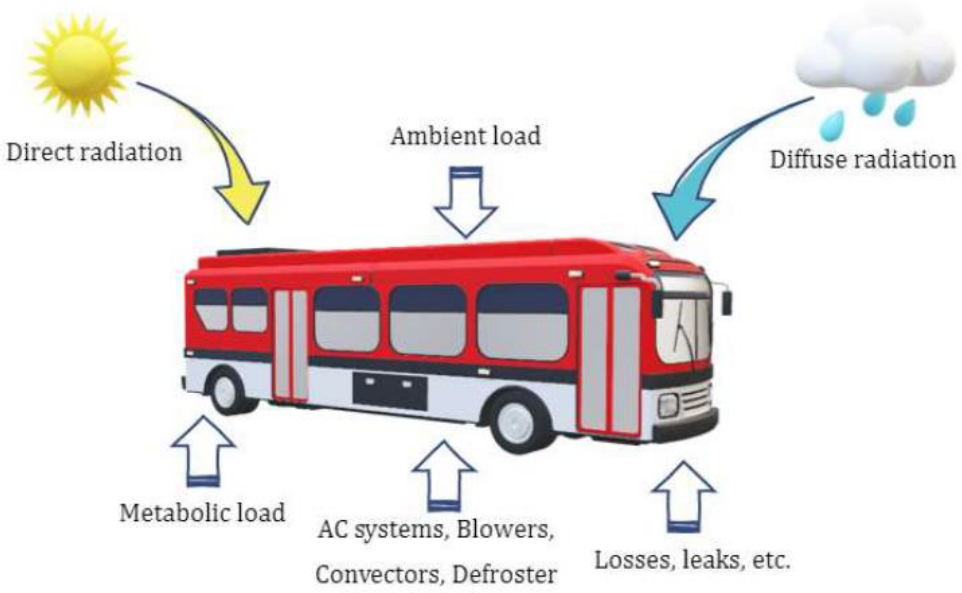
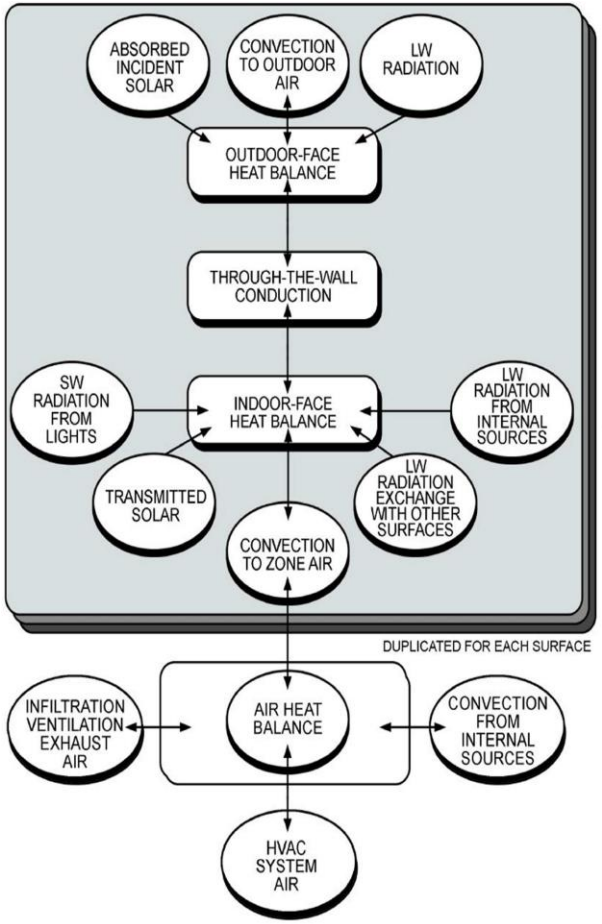
Activity 3.3. Thermal model of the indoor climatic environment

D3.3.1 Thermal model

Heat balance method for an electric bus





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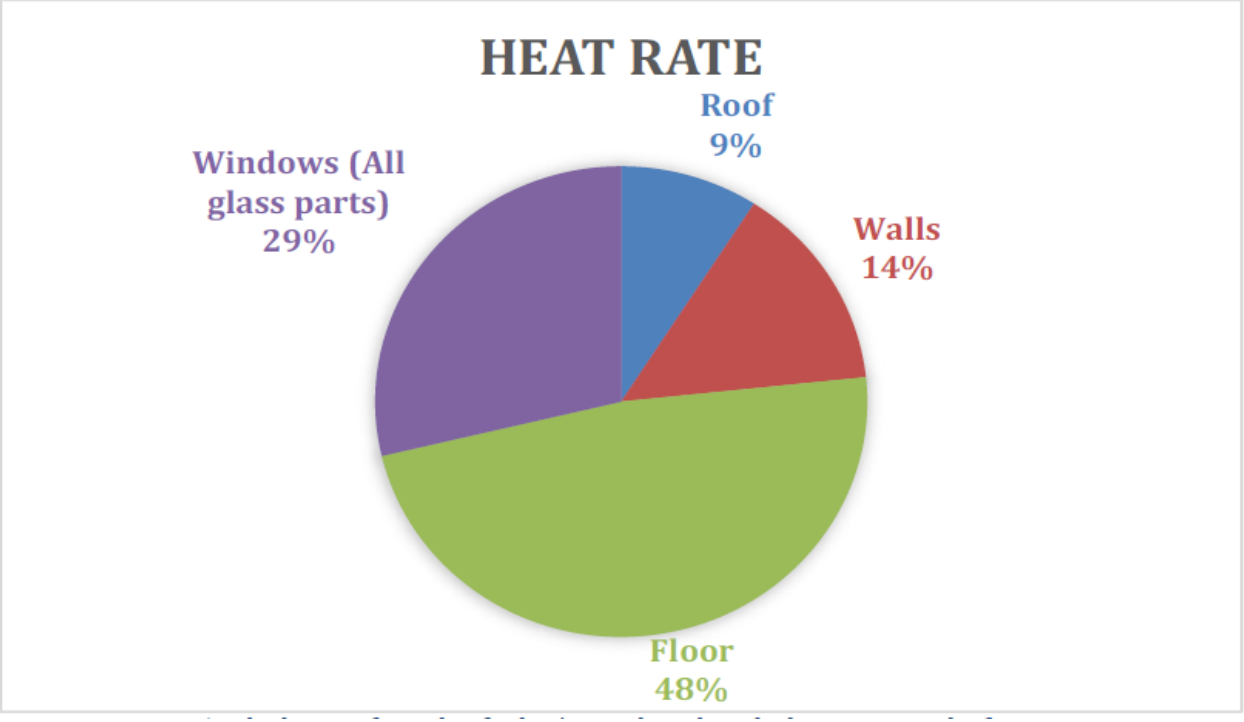
Activity 3.3. Thermal model of the indoor climatic environment

D3.3.1 Thermal model

Calculation of U-Value for bus's part based on the heat rate results



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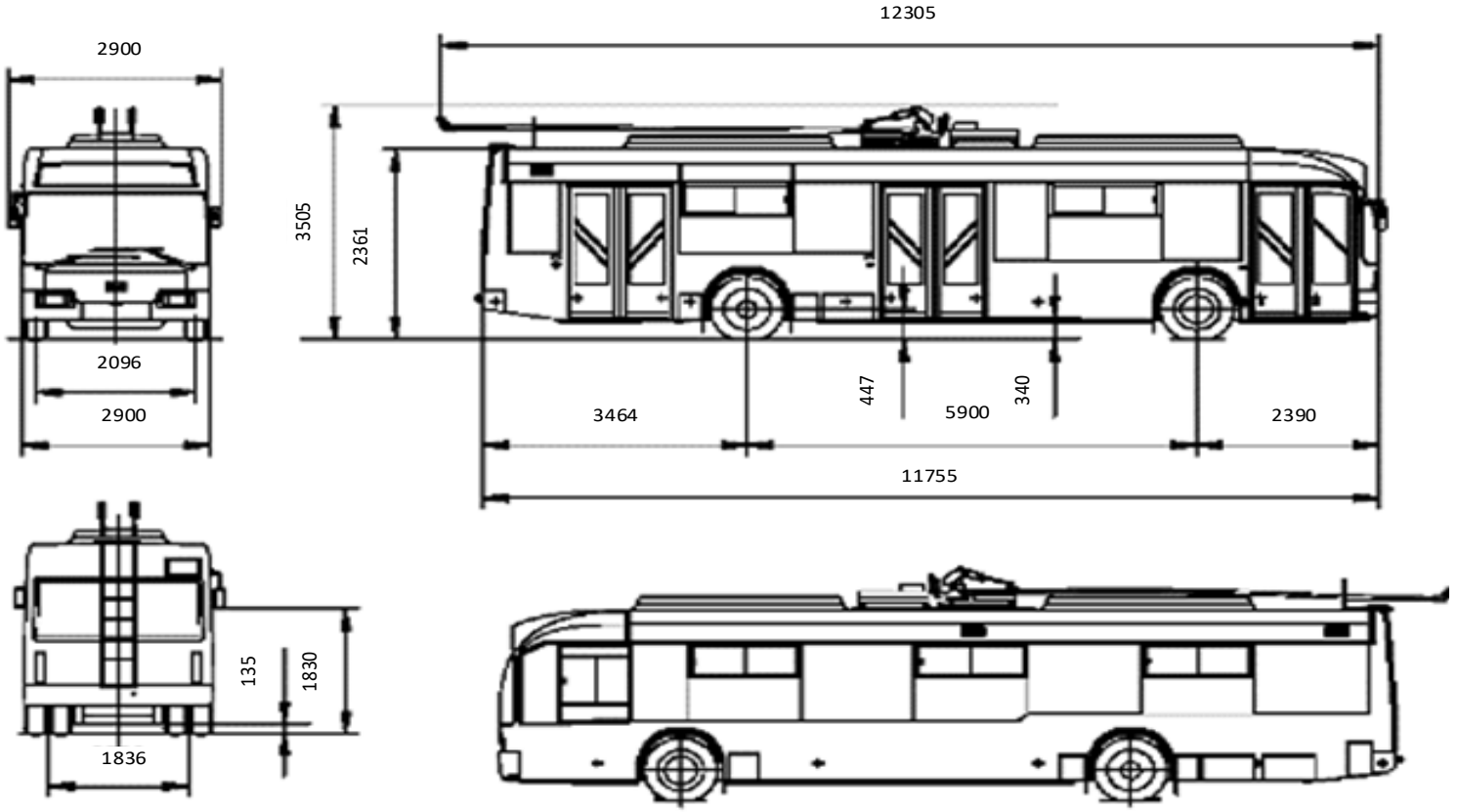
Activity 3.3. Thermal model of the indoor climatic environment

D3.3.1 Thermal model

The main dimensions of the ebus



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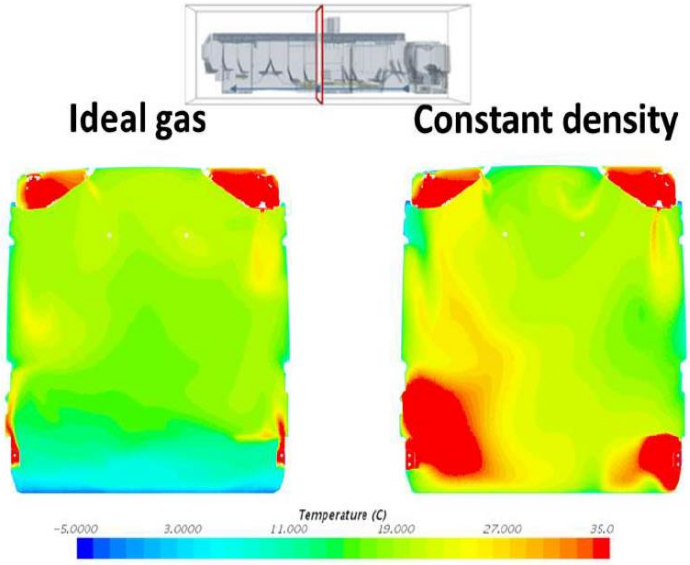
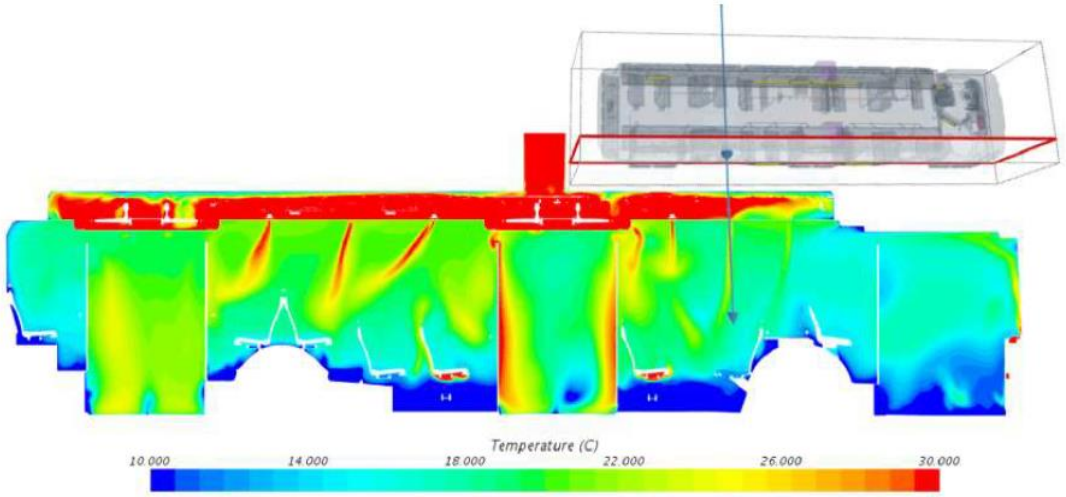
Activity 3.3. Thermal model of the indoor climatic environment

D3.3.1 Thermal model

A CFD results shows temperature distribution for a similar case results from GT-SUITE





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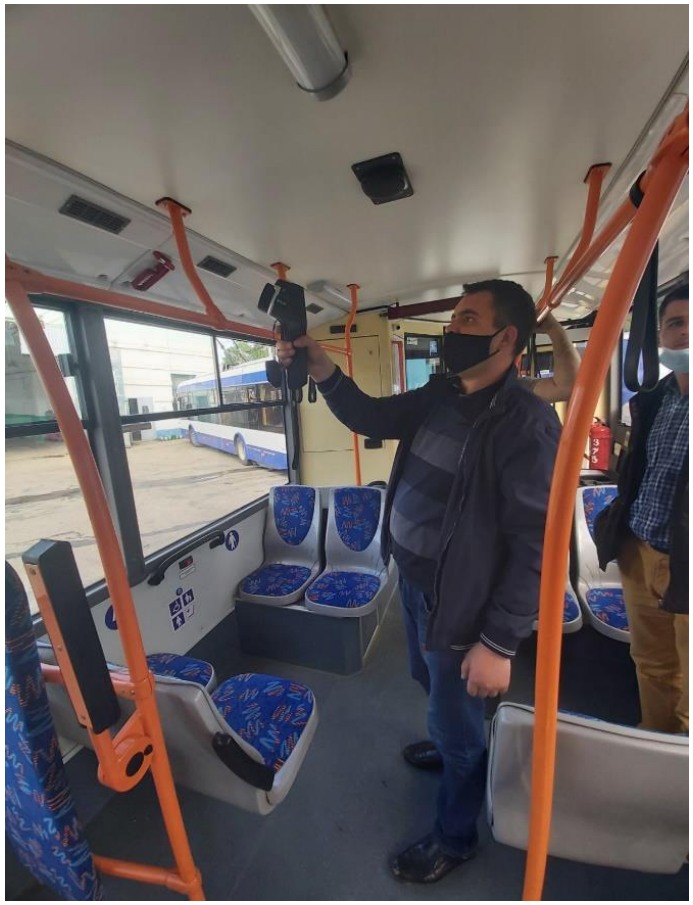
Activity 3.3. Thermal model of the indoor climatic environment

D3.3.2 Thermal map for the indoor climatic environment



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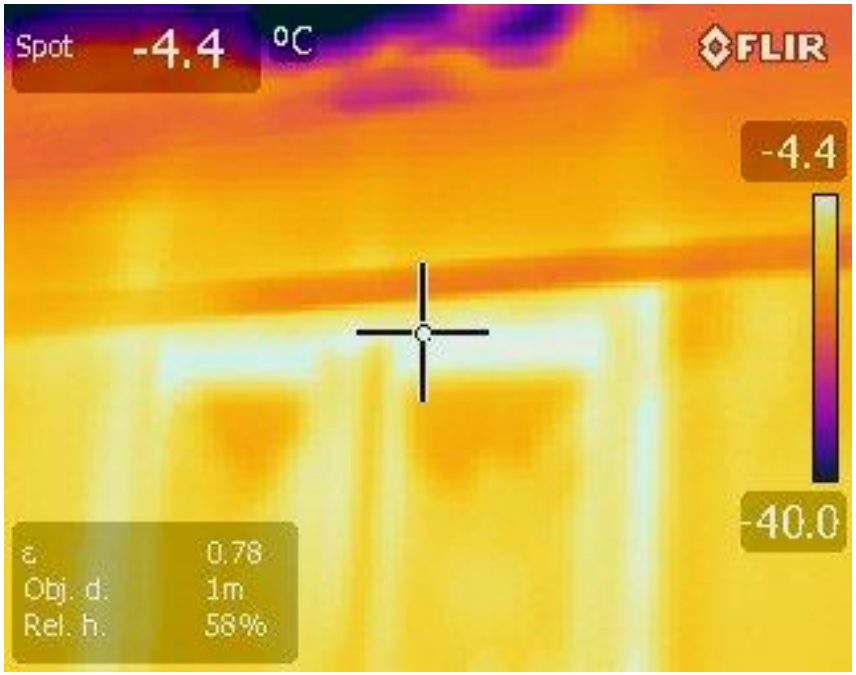
Activity 3.3. Thermal model of the indoor climatic environment

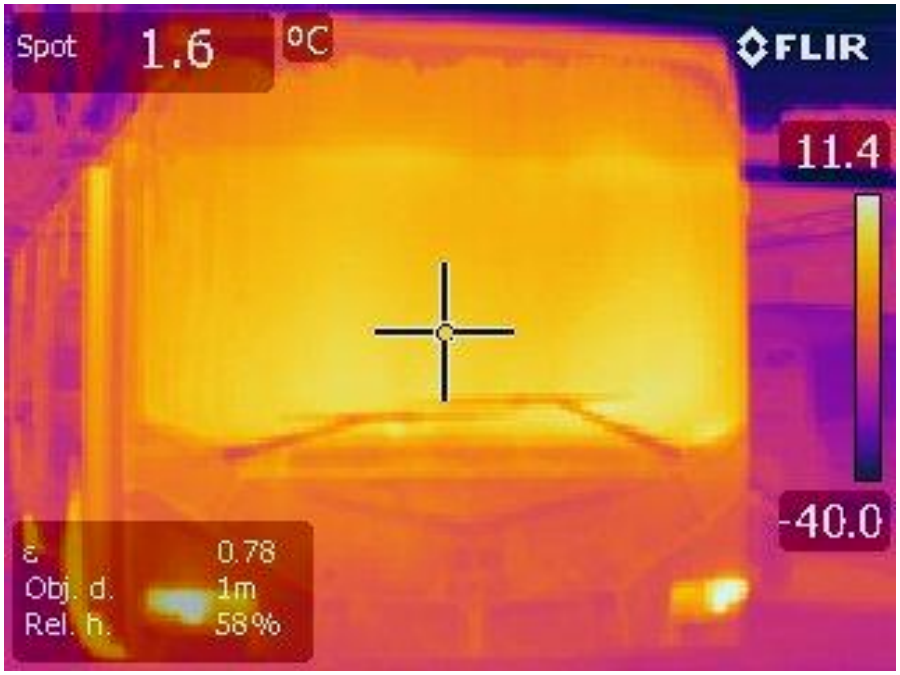
D3.3.2 Thermal map for the indoor climatic environment

Thermal image for detection of high temperature and (potentially) high energy loss areas in an ELECTRIC BUS E321 which is exploited in Chisinau city.

The back door of the bus



Temperature map of the front side of the bus



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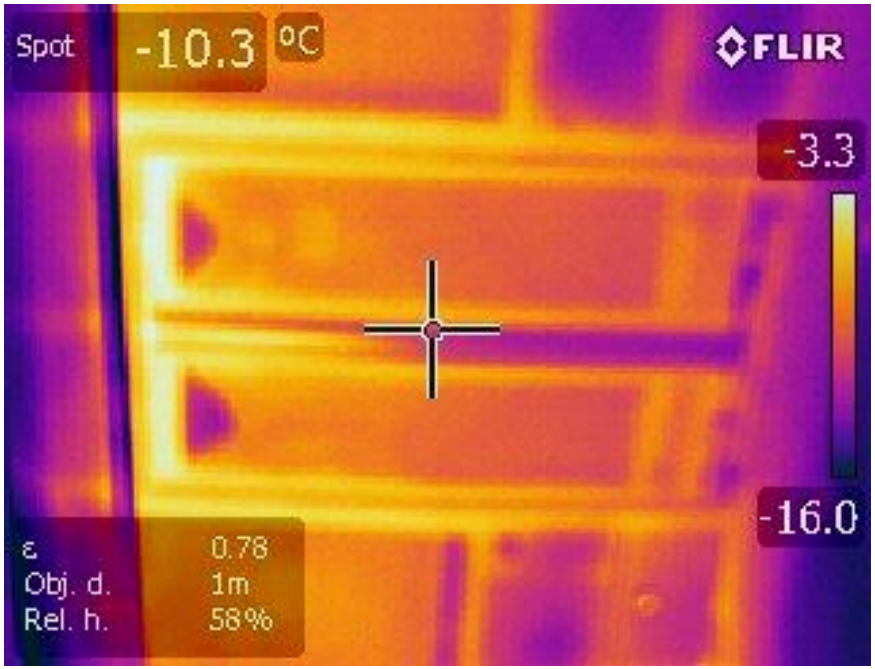
Activity 3.3. Thermal model of the indoor climatic environment

D3.3.2 Thermal map for the indoor climatic environment

General view from the right side of the bus

Temperature map at the middle door of the bus



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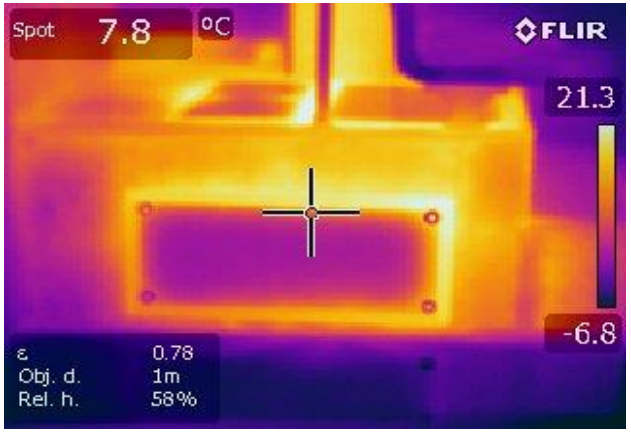

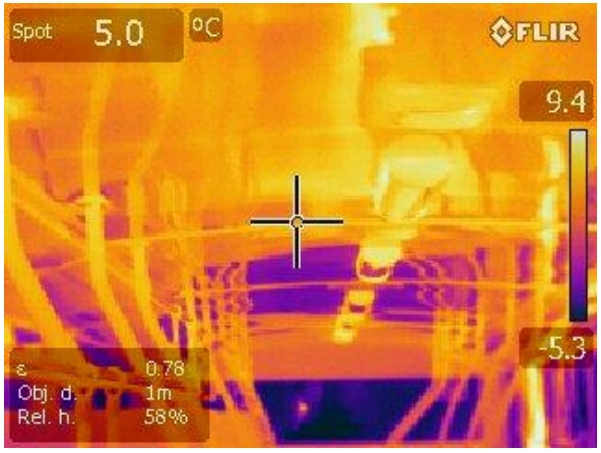

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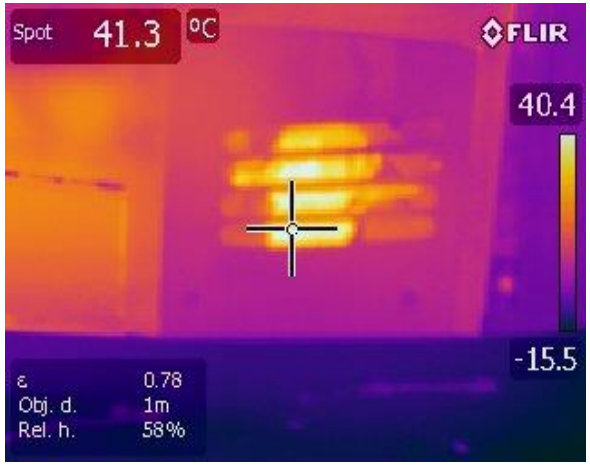

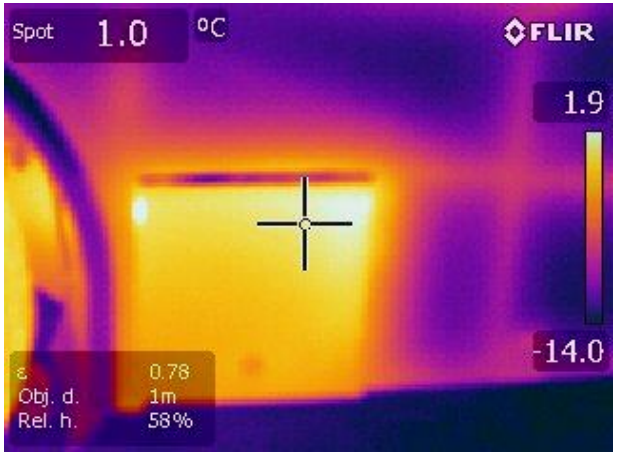

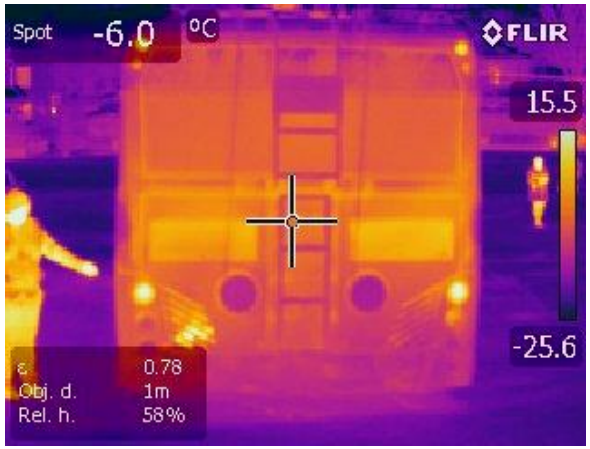

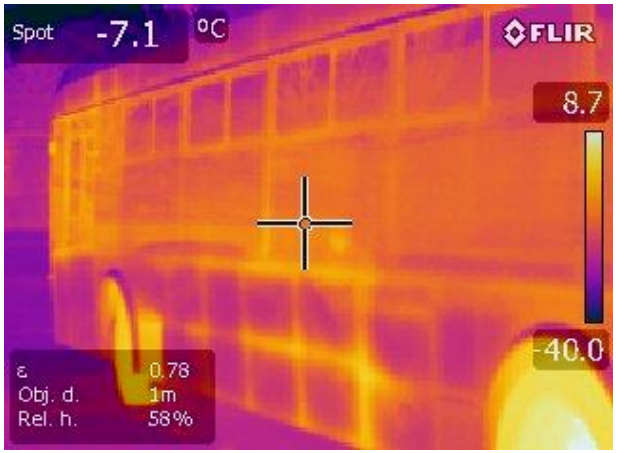

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Conclusions

- Energy consumption for auxiliaries accounts for almost half of total energy consumption, and in the winter it reaches 70% in daily scale. Taking into account the high efficiency of currently operated propulsion systems, the main way to reduce energy consumption in transport is to reduce the energy consumption of auxiliaries.
- Thermal aspects are studied for the efficiency increasing of the electric bus, including the heat recovery from the batteries, control of the heating and cooling system into the indoor of the vehicle, reducing the heat losses by the windows and vehicle walls with thermal isolation materials.
- It is proposed to use the infrared heating system on electric buses, which has advantages over other heating systems.