HEAT4COOL

Life Cycle Analysis

Dr. Emil Lezak (IZNAB)

IZNAB, Themowatt, Hypertech, Tecnalia, Sunamp, AES Solar, Symelec

Heat4COOL project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 723925

Timeline of T6.5

Task 6.5 Life-Cycle Analysis	
Establishing methodology for LCA	April 2019
Develop a template of LCI (by TECNALIA)	September 2019
First draft of D6.8 with Pilot Case of Valencia	October 2020
Updated version with Pilot Case of Chorzow	December 2020
Updated version with Pilot Case of Budapest / Sofia	February 2021
Final version released to the Coordinator	April 2021
Checked final version after internal review and submitted to EC	May 2021

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LCA four stages
(ISO 14040/44)

Stage 1: Goal and scope aims to define product life cycle and criteria applied to system comparison.

Stage 2: Inventory analysis gives a description of material and energy flows, interaction with environment, consumed raw materials and emissions to the environment.

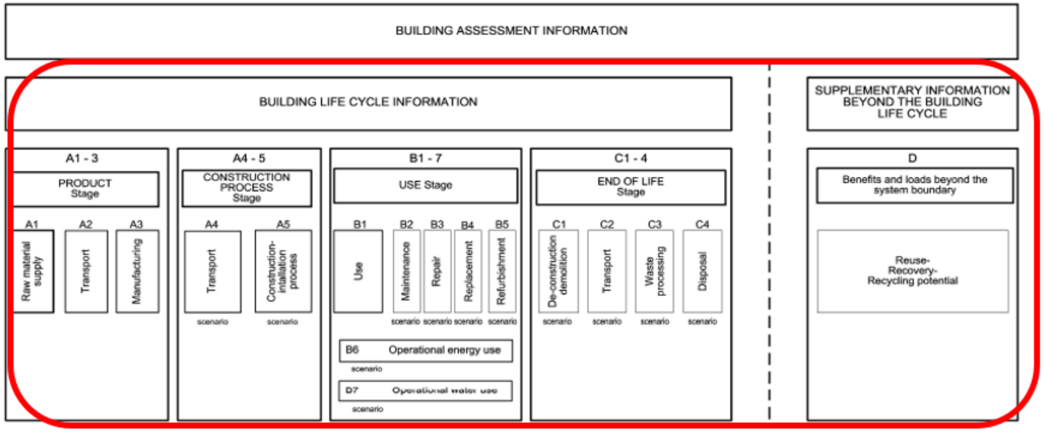
Stage 3: Impact assessment with data from inventory analysis, indicator results applying normalization and weighting.

Stage 4: Interpretation, critical review, determination of data sensitivity, and result presentation.

LCA boundaries			Life cycle stages	Life cycle stage designation and description	
Cradle to cradle	Cradle to grave	Cradle to gate	Product stage	A1	Raw material extraction and processing, processing of secondary material input
				A2	Transport to the manufacturer
				A3	Manufacturing
			Instalation process stage	A4	Transport to the Building site
		Gate to grave		A5	Installation into the Building site
			Use stage – information modules related to the Product/Material	B1	Use or application of the installed product
				B2	Maintenance
				B3	Repair
				B4	Replacement
				B5	Refurbishment
			Use stage – information modules related to the operation of the Customer site	B6	Operational energy use
				B7	Operational water use
			End-of-life stage	C1	Deconstruction, demolition
				C2	Transport to waste processing
				C3	Waste processing for reuse, recovery and/or recycling (3R)
				C4	Disposal
			Benefits and loads beyond the system boundary	D	Reuse, recovery and/or recycling (3R) potentials

LCA templates
(by TECNALIA; UNE EN-15978)

			LCA	LCC
PRODUCT stage	A1	Raw material supply	√	√
	A2	Transport	√	√
	A3	Manufacturing	√	√
CONSTRUCTION PROCESS stage	A4	Transport	√	√
	A5	Cosntruction-Installation process	√	√
USE stage	B1	Use	√	√
	B2	Maintenance	√	√
	B3	Repair	√	√
	B4	Replacement	√	√
	B5	Refurbishment	√	√
	B6	Operational energy stage	√	√
	B7	Operational water stage	√	√
END OF LIFE stage	C1	De-construction demolition	√	√
	C2	Transport	√	√
	C3	Waste processing	√	√
	C4	Disposal	√	√
SUPPLEMENTARY INFORMATION BEYOND THE BUILDING LIFE	D	Re-use	√	√
		Recycling	√	√
		Energy recovery	√	√



Functional unit: One residential building with a heated area of XX m2 for a service life of 50 years

This sheet aims to collect environmental and economical data about the product stage, meaning:

PRODUCT stage	A1	Raw material supply
	A2	Transport
	A3	Manufacturing

General Information

Functional unit:		*Quantified performance of a product system for use as a reference unit, the main purposes of a functional unit is to provide a reference from which input and output data are normalized.*
Reference unit:		*Unit for which the data provided in the questionnaire is referred. To be defined by the person filling the questionnaire. For example: 1 heat pump*
Manufacturing place:		*Location of the manufacturing place*
Life expectancy		*years*
FLOWCHART:		*Description of the manufacturing process considering the components specified behind*
Weight		*kg*

LCA templates

(by TECNALIA ; UNE EN-15978)

			LCA	LCC
PRODUCT stage	A1	Raw material supply	√	√
	A2	Transport	√	√
	A3	Manufacturing	√	√

BUILDING ASSESSMENT INFORMATION

SUPPLEMENTARY INFORMATION

Costs information

DESIGN AND ENGINEERING COST (€)	
MANUFACTURING TOTAL COST (€)	
MATERIAL COST (€)	

Environmental Inputs

Component	Type of input	Description	Quantity	Unit	Costs (€)	Kilometers from provider to manufacturing place	Type of vehicle	Cost of the transport (€)	Comments
Component #1	Energy	Please describe The type of energy here							e.g for description: natural gas, diesel, biomass, electricity from grid...
	Material	Please describe The material here							e.g for description: Iron, lithium bromide, polyethylene,...
	Water	Please describe The type of water here							e.g for description: Tap water, water from river,...
Component #2	Energy	Please describe The type of energy here							e.g for description: natural gas, diesel, biomass, electricity from grid...
	Material	Please describe The material here							e.g for description: Iron, lithium bromide, polyethylene,...
	Water	Please describe The type of water here							e.g for description: Tap water, water from river,...
Component #3	Energy	Please describe The type of energy here							e.g for description: natural gas, diesel, biomass, electricity from grid...
	Material	Please describe The material here							e.g for description: Iron, lithium bromide, polyethylene,...
	Water	Please describe The type of water here							e.g for description: Tap water, water from river,...

Please, add rows for each component and for each type of energy, material and water needed during the manufacturing phase

Environmental Outputs

Type of output	Description	Quantity	Unit	Costs ot treatment (€)	Kilometers to treatment plant	Type of vehicle	Cost of the transport (€)	Comments
Emissions to air	Please describe The type of emission to air here							e.g for description: CO2 emissions, Particulates, Nox,...
Emissions to water	Please describe The emission to water here							e.g for description: lithium, bromates,...
Wastes	Please describe The type of waste here							e.g for description: wastewater, lithium bromide, ... please, add a description

Please, add rows for each type emission or waste generated during the manufacturing phase

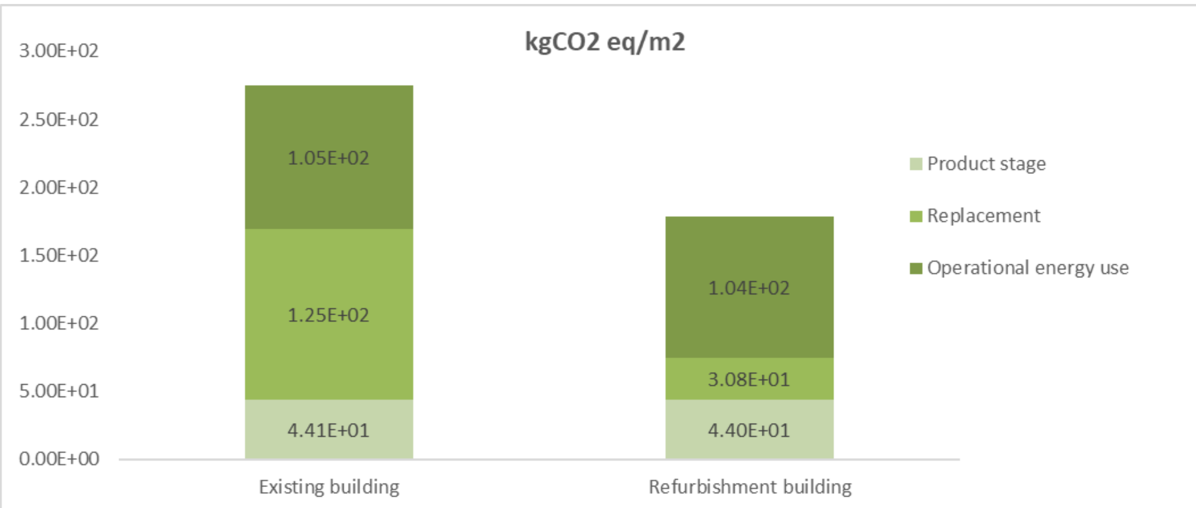
General scope | **Product Stage A1-A3**

Reference unit:		*the person filling the questionnaire. For example: 1 heat pump*
Manufacturing place:		*Location of the manufacturing place*
Life expectancy		*years*
FLOWCHART:		*Description of the manufacturing process considering the components specified behind*
Weight		*kg*

LCA analysis for Valencia demosite

Comparative LCA analysis. Existing building vs. Refurbished building

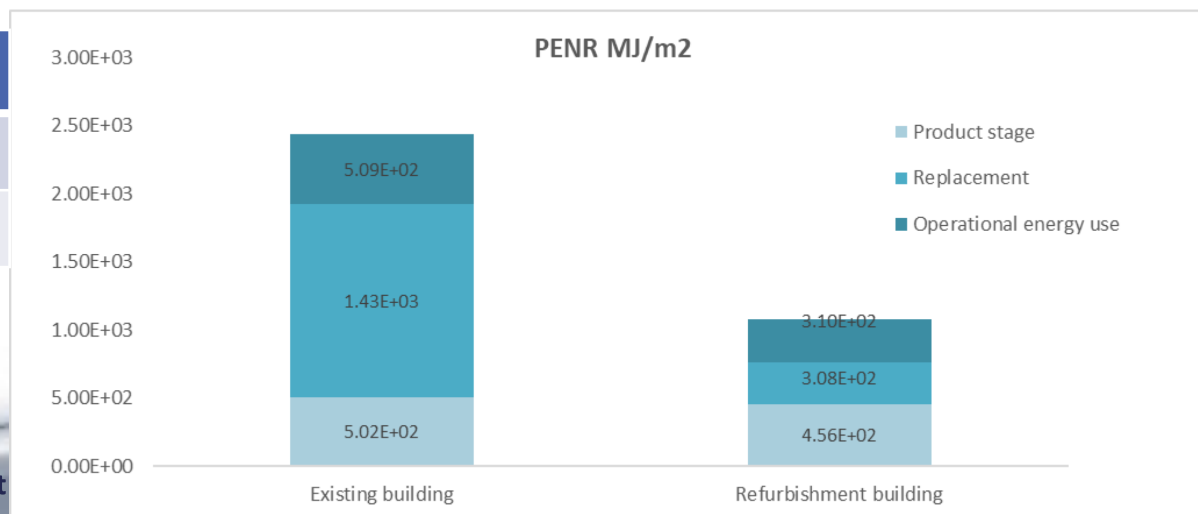
CO2 eq emissions per m2 conditioned



Savings	
Annual GWP savings (Tn CO2 eq/year)	1.17
GWP savings during service life (Tn CO2eq)	58.66

Primary Energy non-renewable (PEnr) used per m2 conditioned

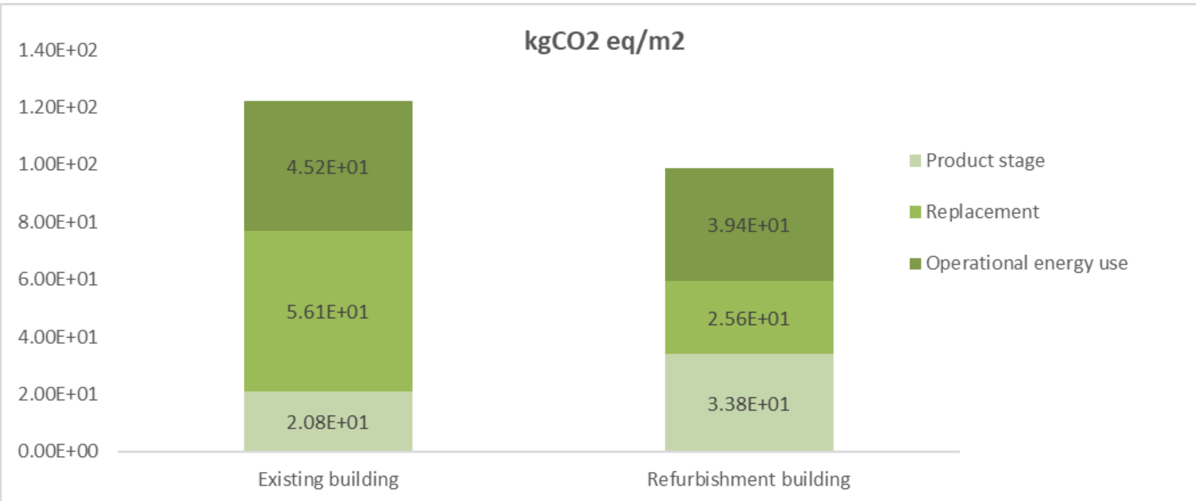
Savings	
Annual PENR savings (MJ/year)	16623.55
PENR savings during service life (MJ)	831177.42



LCA analysis for Sofia demosite

Comparative LCA analysis. Existing building vs. Refurbished building

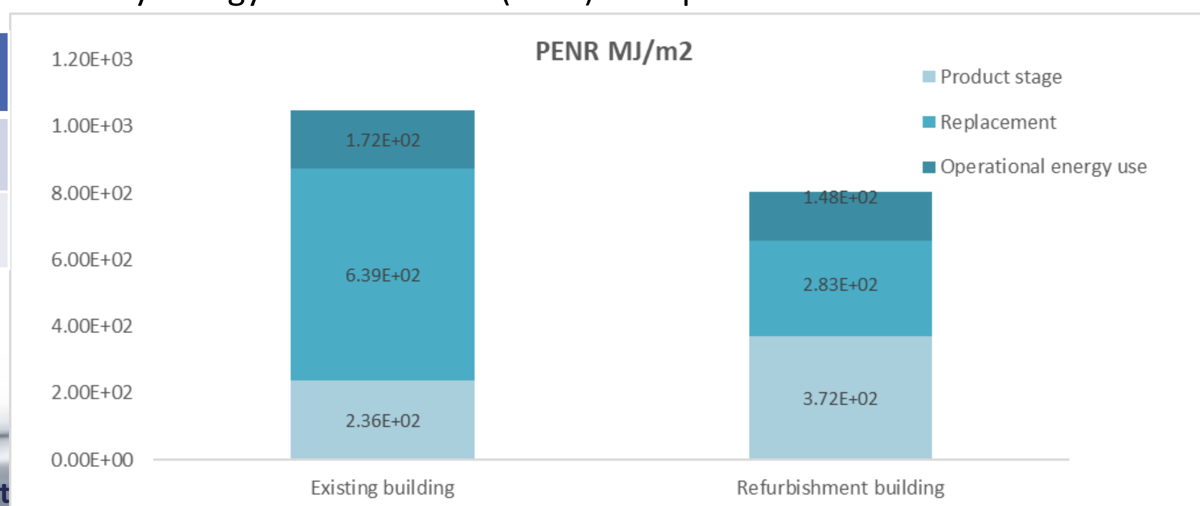
CO2 eq emissions per m2 conditioned



Savings	
Annual GWP savings (Tn CO_2 eq/year)	0.65
GWP savings during service life (Tn CO_2eq)	32.59

Primary Energy non-renewable (PEnr) used per m2 conditioned

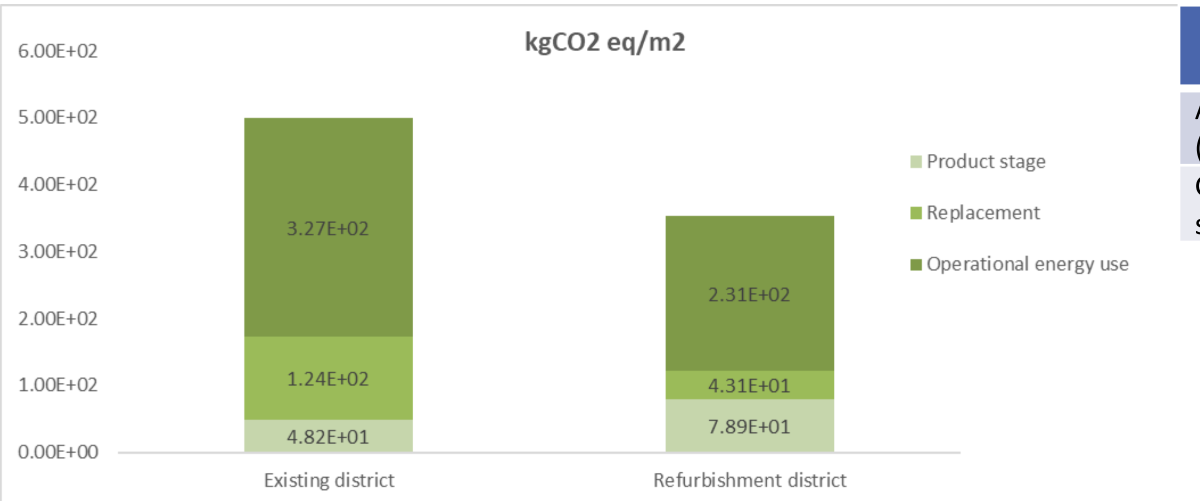
Savings	
Annual PENR savings (MJ/year)	6825.63
PENR savings during service life (MJ)	341331.48



LCA analysis for Budapest district

Comparative LCA analysis. Existing district vs. Refurbished district

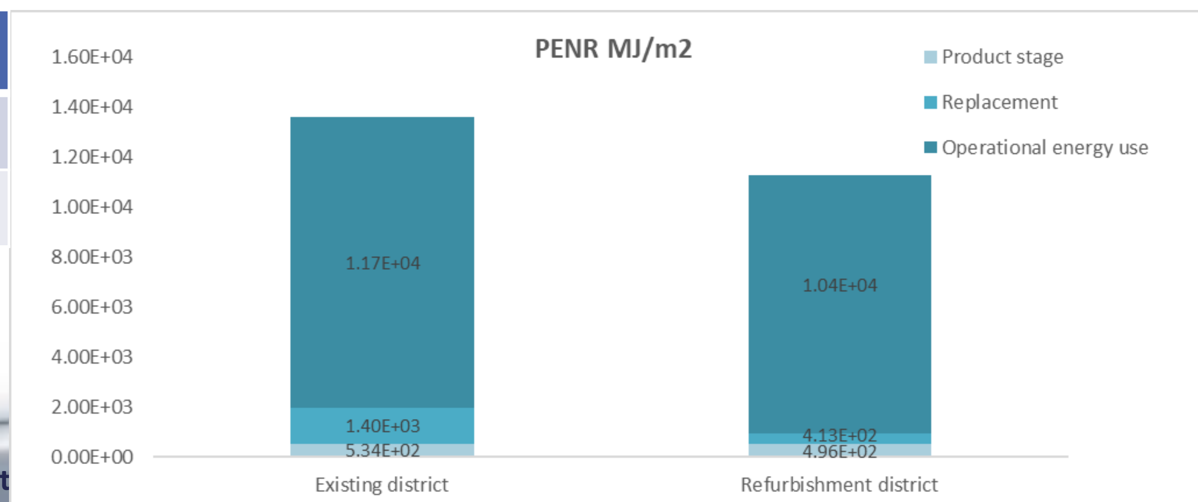
CO2 eq emissions per m2 conditioned



Savings	
Annual GWP savings (Tn CO2 eq/year)	1.90
GWP savings during service life (Tn CO2eq)	95.02

Primary Energy non-renewable (PEnr) used per m2 conditioned

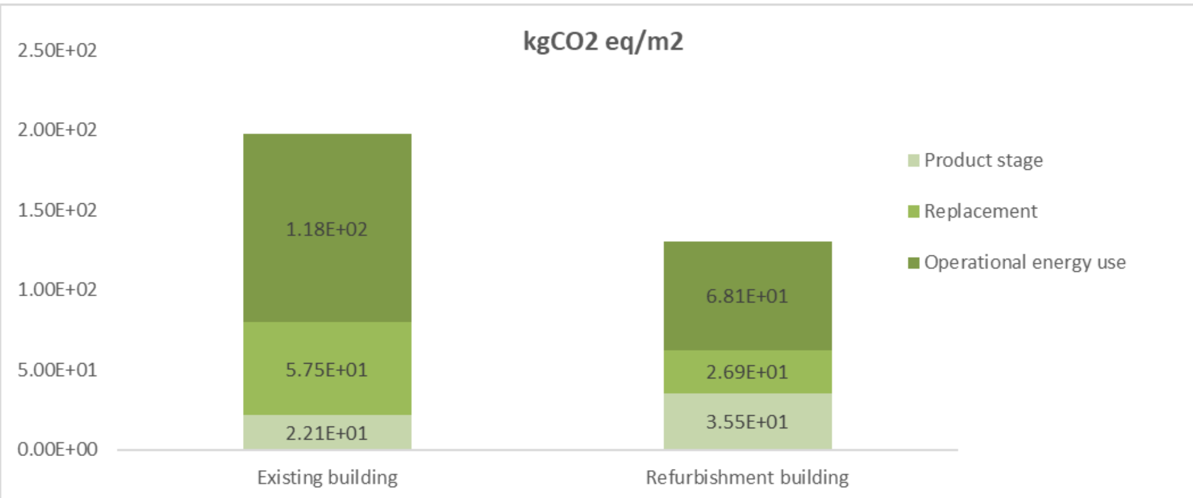
Savings	
Annual PENR savings (MJ/year)	30303.63
PENR savings during service life (MJ)	1515181.65



LCA analysis for Chorzow demosite

Comparative LCA analysis. Existing building vs. Refurbished building

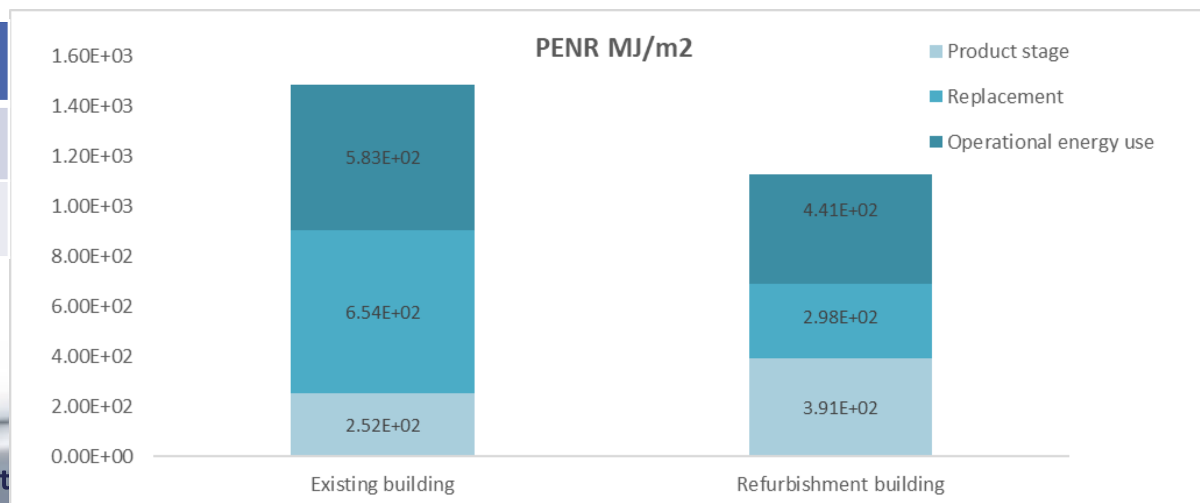
CO2 eq emissions per m2 conditioned



Savings	
Annual GWP savings ($Tn\ CO_2\ eq/year$)	1.88
GWP savings during service life ($Tn\ CO_2eq$)	94.18

Primary Energy non-renewable (PEnr) used per m2 conditioned

Savings	
Annual PENR savings (MJ/year)	10073.19
PENR savings during service life (MJ)	503659.27



Conclusions

- **Energy production in existing pilot buildings** has been responsible for **large quantities of GHGs** associated with the combustion of fossil fuels.
- The implementation of **H4C heating and cooling solutions** resulted in **better energy performance** of each system and allowed a significant reduction of the overall environmental impact.

Savings	Valencia (Spain)	Sofia (Bulgaria)	Budapest (Hungary)	Chorzow (Poland)
CO_2 emissions	29.47%	8.05%	34.34%	16.30%
PENR	10.23%	1.87%	15.05%	1.41%

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Lesson learnt from T6.5

The main issues encountered within the execution of the T6.5 was the period of Covid-19 (Spring 2020) and post-Covid-19 period, related with the restriction of the installation and integration (termination of that activities) of all equipment's of H4C technology solutions at demo sites / district site, and performing of right monitoring (service of monitoring system) of energy performance after retrofitting. This resulted in an incomplete LCI data delivery, and thus caused delays in the LCA calculations, as well as preparation and deliver of D6.8.

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Questions

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Dr. Emil LEZAK
IZNAB SPOLKA Z OGRANICZONA ODPOWIEDZIALNOSCIA
emil.lezak@iznab.pl
(+48) 518 414 114

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Thank you!

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