



**POLITECNICO**  
MILANO 1863



**HOCHSCHULE  
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## WP2.- Retrofitting design planner tool

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- Tasks, deliverables and milestones completed M1-M54.  
Focus on M37-M54
- Planned use of PMs
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# WP objectives



## WP2.- Retrofitting design planner tool

- To develop a reliable design tool that will allow the simulation of the combination of different retrofitting measures (including HVAC, RES and BEMS measures)
- assessing the energy savings of the solutions
- and thus, supporting the retrofitting decision making





# WP final results



Actions ▾ Help ▾

## H4C RetroSim: Retrofitting Design Planner Tool

Introduction

Building

Heating system

Cooling system

Occupancy and thermostat settings

Start



# HEAT4COOL

### Welcome to the H4C Retrofitting Design Planner Tool.

This Retrofitting Design Planner Tool has been developed in the framework of the [Heat4Cool project](#). Its aim is to provide support to users (residents, building administrators, engineers, architects, etc.) in finding the optimum retrofit solution for a particular building, by evaluating the potential of a range of [innovative technologies](#) developed within this project.

In the next screens, the user is asked to enter the characteristics of an existing building, including location, geometry and existing heating/cooling systems (default values are proposed to aid this). Based on these inputs, the Tool generates a number of scenarios incorporating the Heat4Cool technologies that are compatible, and calculates their energy performance. Finally, a screen is presented to the user where all these scenarios are ranked, considering energy consumed, cost, greenhouse gas emissions, as well as the comfort range achieved. A help section is available at the top right area of this screen.

START

<http://80.88.88.178:8080/>

Version 0.4.5





# Tasks completed

## WP2: Retrofitting design planner tool

	M1 oct 2016	M7 apr 2017	M8 may 2017	M12 sep 2017	M13 oct 2017	M15 dic 2017	M16 jan 2018	M17 feb 2018	M18 mar 2018	M17 dic 2017	M48 mar 2020	M54 mar 2021
T2.1 Mapping of European building stock												
T2.2 Creation of toolkit dataset												
T2.3 User requirements, technical spec. & architecture design												
T2.4 Creation of optimisation algorithm for solution set												
T2.5 User Interface design and tool integrated development												
Milestones	M1. H4C RD tool requirements				M2. Tool implementation							

**T2.1 Mapping of European building stock**

**T2.2 Creation of the Heat4Cool Retrofitting design tool kit Dataset**

**T2.3 User requirements, technical specification and architecture design**

**T2.4 Creation of the optimisation algorithm for the solution set**

**T2.5 User Interface Design and tool integrated development)**

## Duration of WP2:

1. Initial planning: 15 months. M1 – M15
2. A 2-month extension for T2.5. January / February 2018 (M17)
3. Continuous updates of the tool as the project evolves and the technologies are developed
4. A final review has required additional effort to properly update the tool and solve identified bugs. Final activities in M48 – M54





# Deliverables & milestones



- **D2.1 / D2.2 / D2.3 / D2.4 / D2.5. Submitted and Approved**
- **MS1 Heat4Cool retrofitting design tool requirements M7**
- **MS2 Heat4Cool retrofitting design tool implementation M15**





# Final Activities during M37-M54



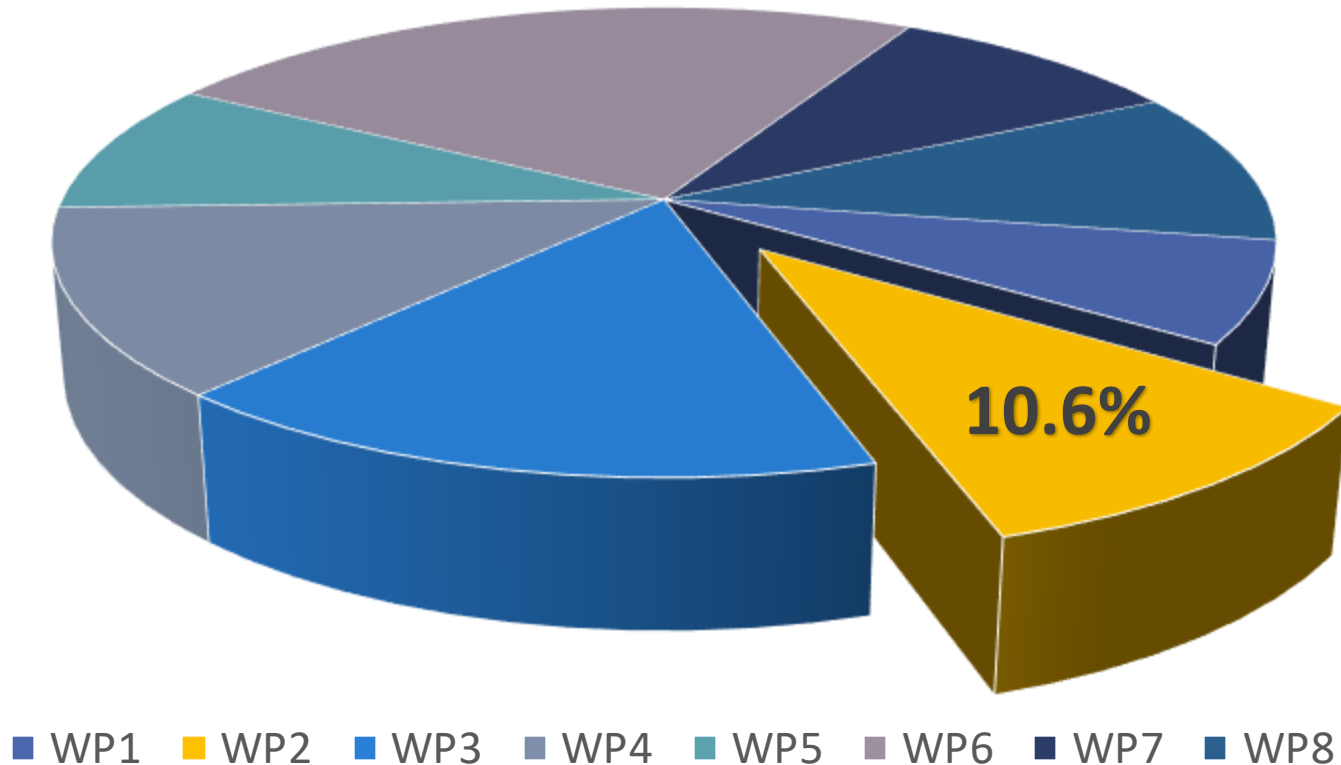
**An overall validation and update of the tool has been performed. This means:**

- Using pilots' results as reference, the calculation system has been modified and updated.**
- Bugs identified during this validation activity as well as in previous periods have been solved. This has affected all the modules composing the tool.**
- The final version of the tool has been published.**





# Planned use of PMs



Associated Key Exploitable Result (KER):

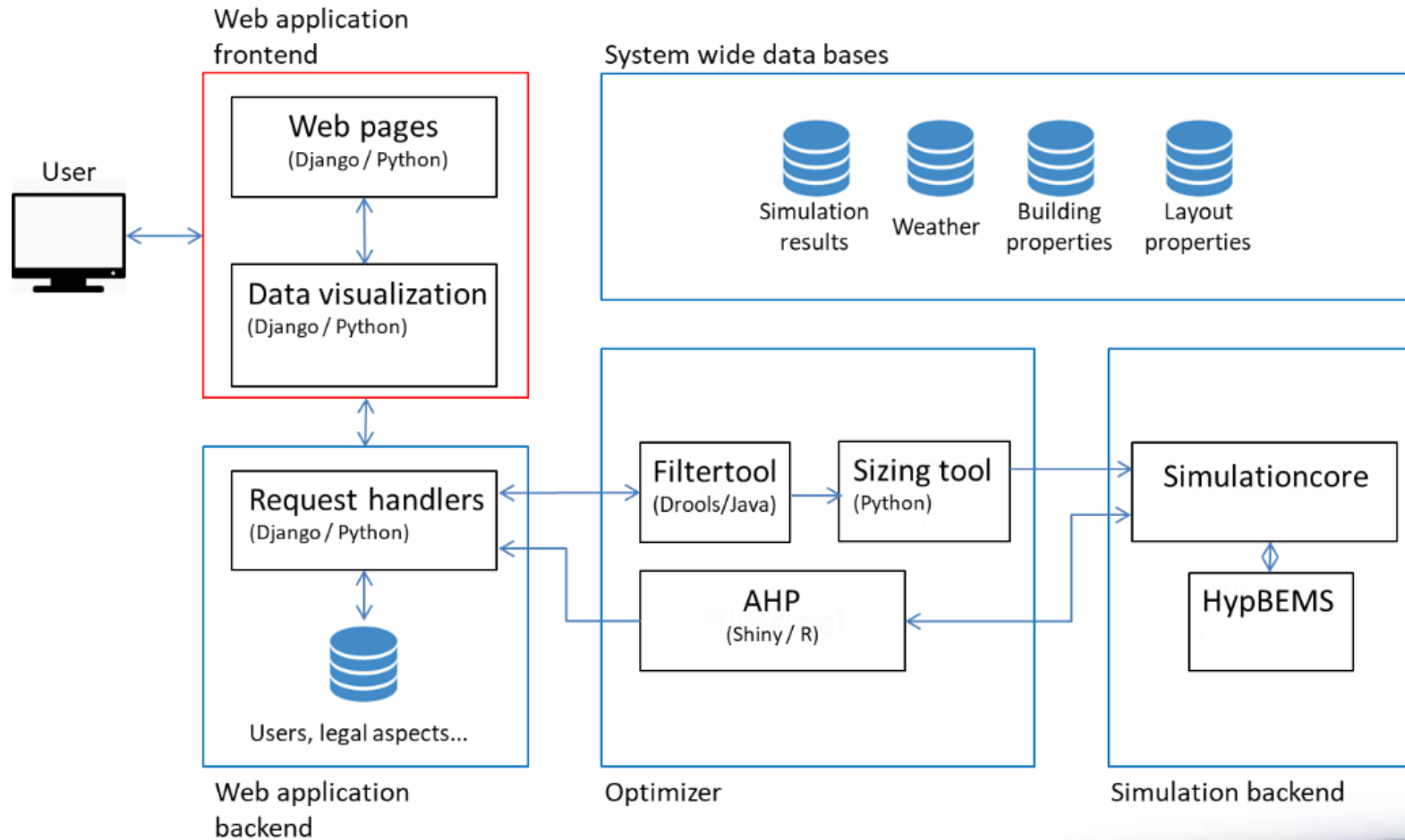
**Retrofitting design planner tool**





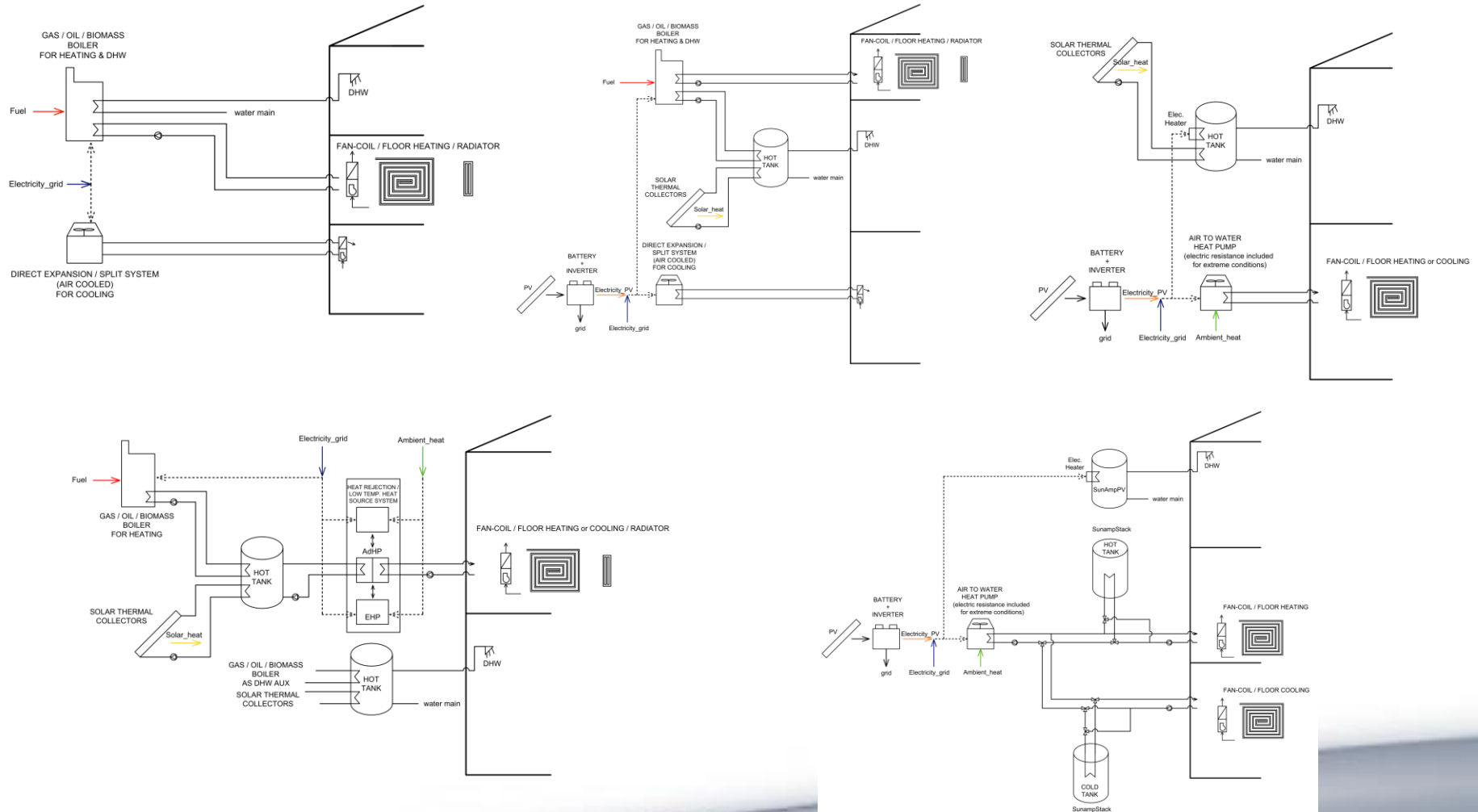


# WP final results





# WP final results





# WP final results



## Building Characteristics

- Building geometry
- Envelope characteristics
- Available space for systems and RES installation

Introduction **Building** Heating system Cooling system Occupancy and thermostat settings Start

### Building characteristics

Which type of building would you like to assess?  
Whole apartment block

When was it built?  
From 1945 to 1969

Where is it located?  
Country: Spain City: Valencia

Building orientation and boundaries

Building size  
Length (m): 13 Width (m): 15.5 Number of storeys: 4

Storey height (m): 3

Orientation angle: deviation from North clockwise (see diagram on the right)  
350

Diagram showing building orientation and boundaries. The diagram is a 3D perspective view of a rectangular building. A North arrow (N) points upwards. The building's walls are labeled: Wall 1 (top right), Wall 2 (bottom right), Wall 3 (bottom left), and Wall 4 (top left). A red arc indicates the orientation angle from North to the top edge of the building.

Wall 1: Exposed to outside. Percentage of windows: 40%.

Wall 2: Adjacent to another building. Percentage of windows: 25%.

Wall 3: Exposed to outside. Percentage of windows: 26%.

Wall 4: Adjacent to another building. Percentage of windows: 25%.

Roof/ceiling: Exposed to outside. Floor slab: Adjacent to another conditioned.

Which percentage of the roof surface is available for solar plants?  
30

Inclination of solar collectors/panels (from horizontal)  
24

Thermal insulation of the building envelope ( $\text{W/m}^2\text{K}$ )  
U-value of walls: 0.47 U-value of the roof: 0.273

Orientation of solar collectors/panels (deviation from South)  
114

How much area is available for new technical equipment ( $\text{m}^2$ )?  
5

U-value of the ground floor: 0.448 U-value of windows: 2.89

Thermal bridges heat loss: Medium Thermal bridges heat loss ( $\text{W/m}^2\text{K}$ ): 0.1

Ventilation system with heat recovery: No Unintended air leakage: Medium

Thermal capacity of external walls: Mediumweight Thermal capacity of internal walls and slabs: Mediumweight

Thermal capacity of external walls ( $\text{J/m}^2\text{K}$ ): 65000 Thermal capacity of internal walls and slabs ( $\text{J/m}^2\text{K}$ ): 65000



# WP final results



Introduction Building **Heating system** Cooling system Occupancy and thermostat settings Start

### Heating system characteristics

Which energy source is used for space heating and domestic hot water?  
Natural gas

Which device is used for heating water?  
Boiler

Which type of emitter system is present?  
Radiators

Which type of heat pump is used?  
None

Is there a hot water storage tank?  
☒ Yes  
☐ No

Back Next

## Heating and cooling system

Based on the existing heating and cooling systems, the «Current» layout is identified (layout 1, 2 or 3) and the filter tool defines the alternatives scenarios

Introduction Building Heating system **Cooling system** Occupancy and thermostat settings Start

### Cooling system characteristics

Which device is used for cooling in summer?  
Direct expansion system

☒ Show advanced controls

Back Next





# WP final results

## Occupancy and thermostat settings

Occupancy and thermostat profiles can be chosen among predefined schedules or customized using the advanced options weekly schedules.

[Introduction](#) [Building](#) [Heating system](#) [Cooling system](#) [Occupancy and thermostat settings](#) [Start](#)

### Occupancy

How many occupants are there in the building?

What is the schedule of the building?

### Thermostat settings: heating

What is the thermostat setpoint schedule?

Standard temperature

Setback temperature

### Thermostat settings: cooling

What is the thermostat setpoint schedule?

Standard temperature

Setback temperature

☐ Show advanced controls [Back](#) [Next](#)



### Monday

Copy from

Start	End	T setpoint	In use	
00:00	00:00		<input type="checkbox"/>	<a href="#">Edit</a>
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### Wednesday

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### Friday

Copy from

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00:00	00:00		<input type="checkbox"/>	<a href="#">Edit</a>





# WP final results

Introduction Building Heating system Cooling system Occupancy and thermostat settings **Start**

### Coefficients

Coefficient	Electricity	Gas	Biomass	Oil	Coal	
Nonrenewable Primary Energy Factor	2.3	1.1	0.2	1.1	1.1	
Renewable Primary Energy Factor	0.2	0	1	0	0	
CO2 Energy Factor	0.437	0.228	0.038	0.299	0.377	
Fuel Cost	0.228	0.086	0.035	0.058	0.01	

### Multicriteria analysis profiles

Basic profile

☒ Show advanced controls

## Coefficients and multicriteria profiles

- Reference coefficients are pre-loaded for each country, based on national documentation and international standard EN ISO 52000
- The user can customize the coefficients and the multicriteria profile to simulate different scenarios in the Analytical Hierarchy Process (AHP)





# WP final results

## Execution

- In the execution status, the steps are listed once completed.
- One simulation at a time can be run. If another simulation is already running, you have to wait in queue.

### Executing simulation...

Simulation in queue : this can take some minutes, please wait...

000 Simulator Engine started!

001 Simulation of the Energy Needs completed ...

002 Filter Tool Completed ...

003 Sizing tool data...

003 Sizing tool completed ...

004B Number of simulations under test:6

004B Simulation 1 executed successfully

004B Simulation 2 executed successfully

004B Simulation 3 executed successfully

004B Simulation 4 executed successfully

### Executing simulation...

Simulation in queue : this can take some minutes, please wait...





# WP final results



## Support

Click the button to contact the development team and share your thoughts, report a bug and/or ask a question

Contact us

- Continuous support by the development team
- The user can contact us to share thoughts and observations, report a bug, ask questions







## KPI overview

# WP final results



- The layout are ranked by the AHP on the basis of:
  - Primary energy
  - Greenhouse gas emissions
  - Comfort deviation

Simulations KPI overview

Simulation name	Layout	Ranking	Non-renewable primary energy (kWh/m2/y)	Renewable energy contribution	Greenhouse gas emissions (kgCO2eq/m2/y)	Electricity fed to the grid (kWh/y)	Average Comfort deviation (°C)	Technical and regulatory information
+AdHP+EHP+SC	4	1	19.2	90%	3.7	0.00	-1.01	<a href="#">show</a>
+AdHP+EHP+SC+BEMS	4	2	19.0	90%	3.7	0.00	-1.01	<a href="#">show</a>
Current	2	3	59.3	1%	12.1	0.00	-1.14	
+BEMS	2	4	59.1	1%	12.1	0.00	-1.14	<a href="#">show</a>
+EHP+PV+PCM+BEMS	5	5	67.8	70%	12.9	11252.66	-0.99	<a href="#">show</a>

Hover a table row to read a brief description of the components

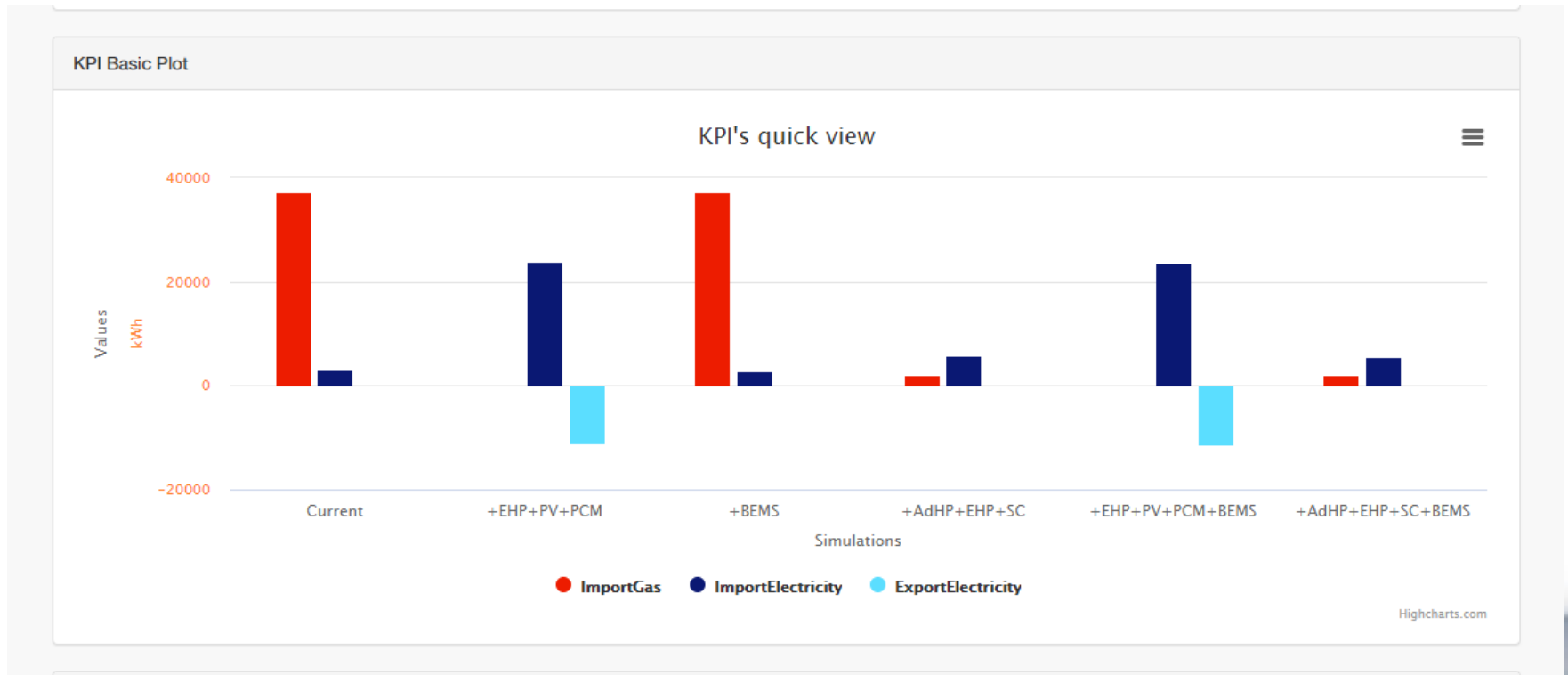




# WP final results



Fuel and electricity import and export are plotted and compared for each layout



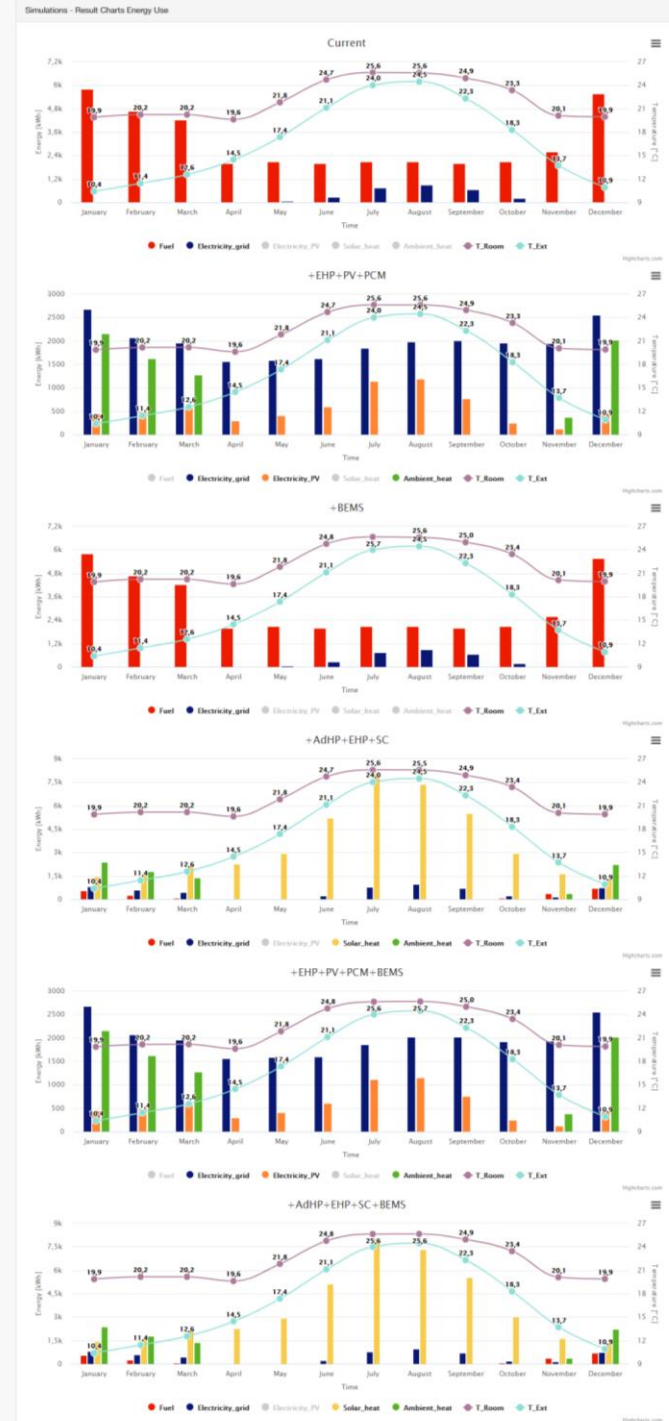


# WP final results

## Simulations Results

The monthly values of energy use are shown for each layout:

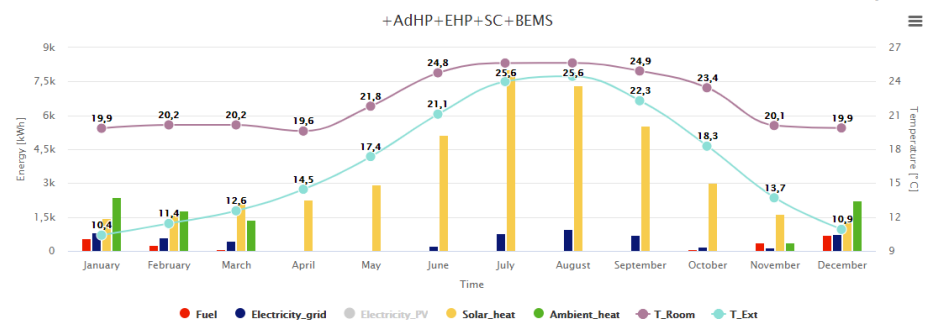
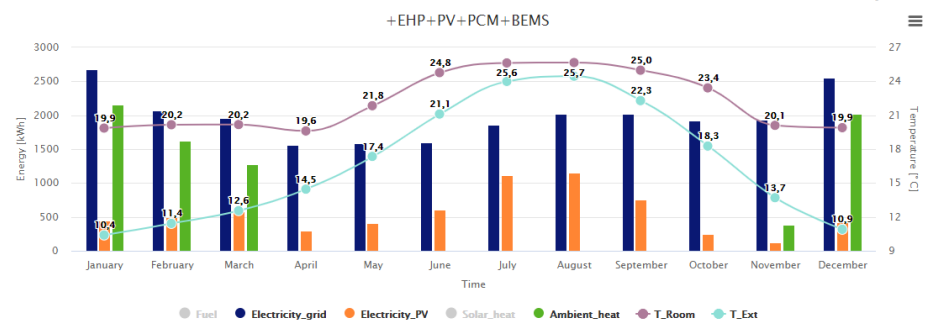
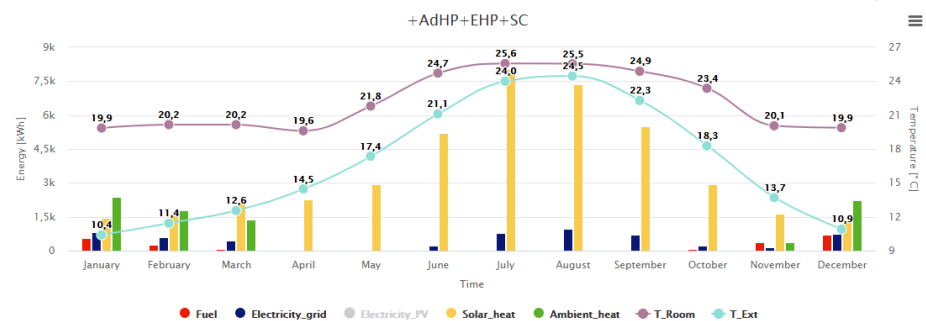
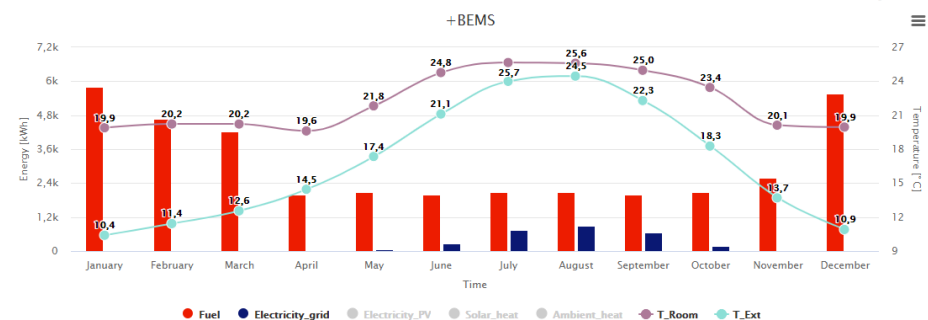
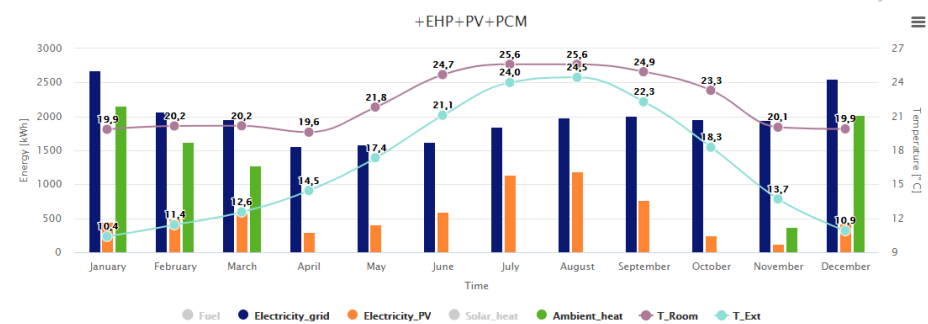
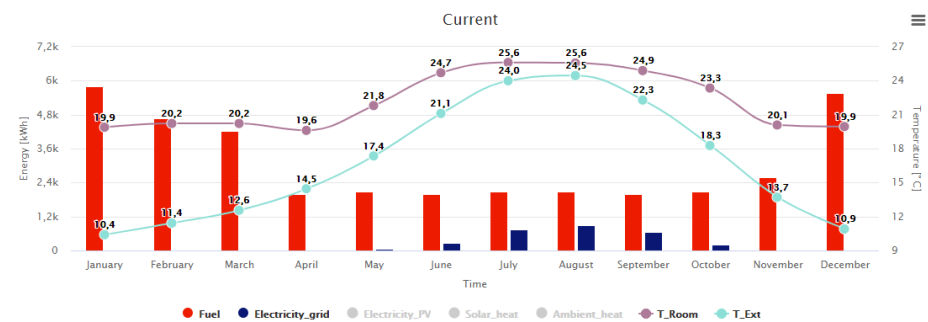
- Fuel consumption (Gas, Oil, Biomass, Coal)
- Electricity imported from grid
- Electricity produced by PV and directly consumed
- Thermal energy produced by solar thermal collectors)
- Ambient heat





# WP final results

## Simulations Results





# Issues encountered / lessons learnt



- The results of the tool for simulating relevant scenarios are validated and are useful for the intended use of the tool.
- The validation of the tool was not foreseen. The valuable results during the development of the project but, mainly, at the end, are necessary to provide feedback to the tool. As a consequence, additional dedication was required.
- The design of the tool based on modules has benefits: Gives flexibility as well as a good opportunity to share the development between different involved partners. However, this approach supposed an additional complexity when the modules needed to be integrated in the final version of the tool.





# Conclusions



- **As a result of WP2, the H4C RetroSim tool has been developed and is available online**
- **Main features of the tool are:**
  - Quick assessment
  - Different alternatives are considered depending on the case
  - Innovative H4C solutions are simulated
  - The tool has a high degree of flexibility to configure scenarios
  - Specific modules developed for: Filtering, sizing, simulating, controlling and ranking of alternatives





# Thank you

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