



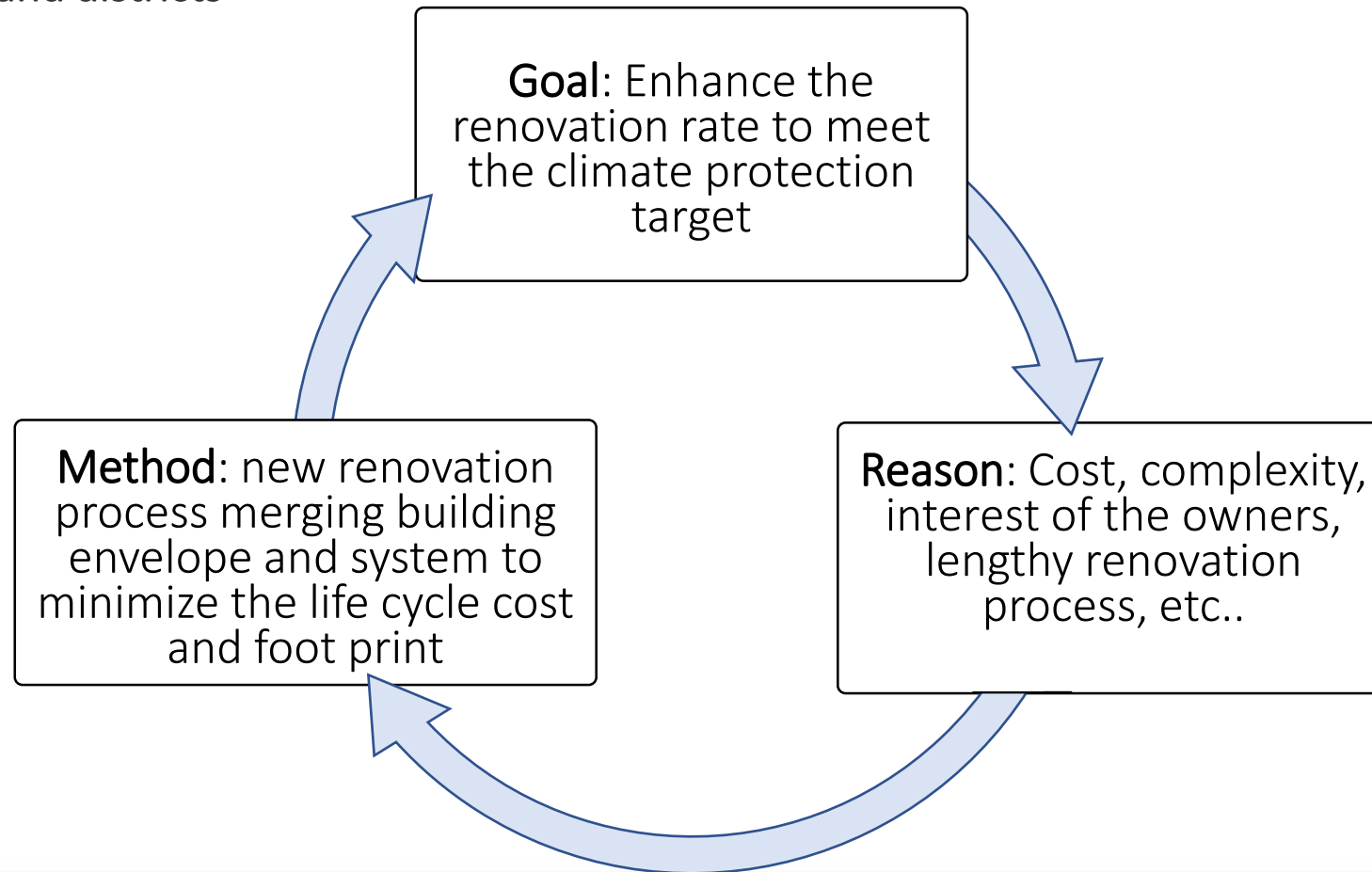
SUPPORTING THE DECISION-MAKING PROCESS RELATED TO THE RENOVATION OF MULTI-FAMILY HOUSES

Mara Magni¹, Fabian Ochs¹, Armin Knotzer², Thomas Roßkopf-Nachbaur³, Georgios Dermentzis¹, Elisa Venturi¹, Dagmar Jähnig²
Unit for Energy Efficient Buildings, University of Innsbruck¹; Institute for Sustainable Technologies (AEE INTEC)²; Energie-Institut Vorarlberg, Energieeffizientes Bauen (EIV)³

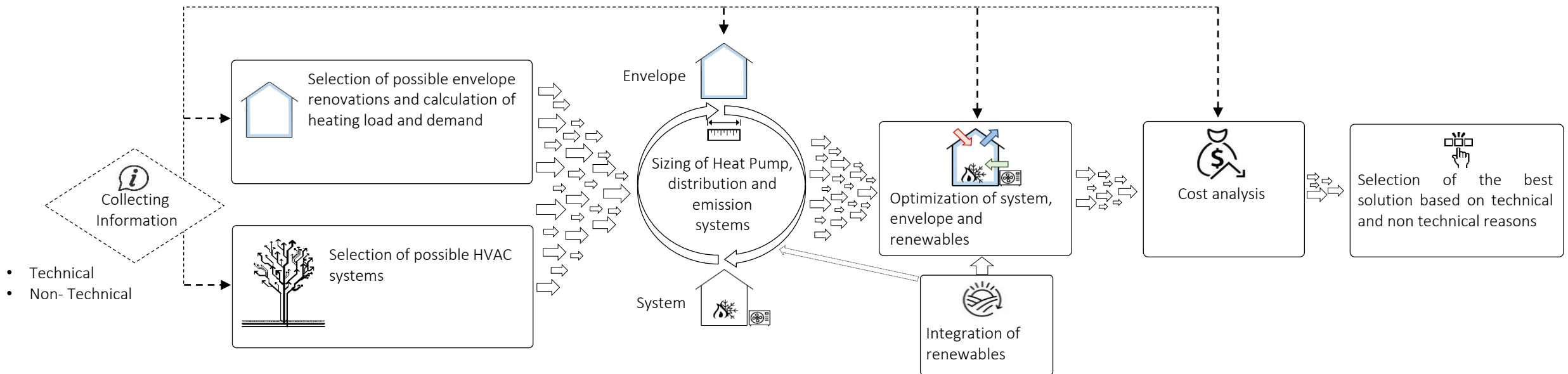
The University of Innsbruck was founded in 1669 and is one of Austria's oldest universities. Today, with over 28.000 students and 5.000 staff, it is western Austria's largest institution of higher education and research. **For further information visit: www.uibk.ac.at.**

Aim of this work

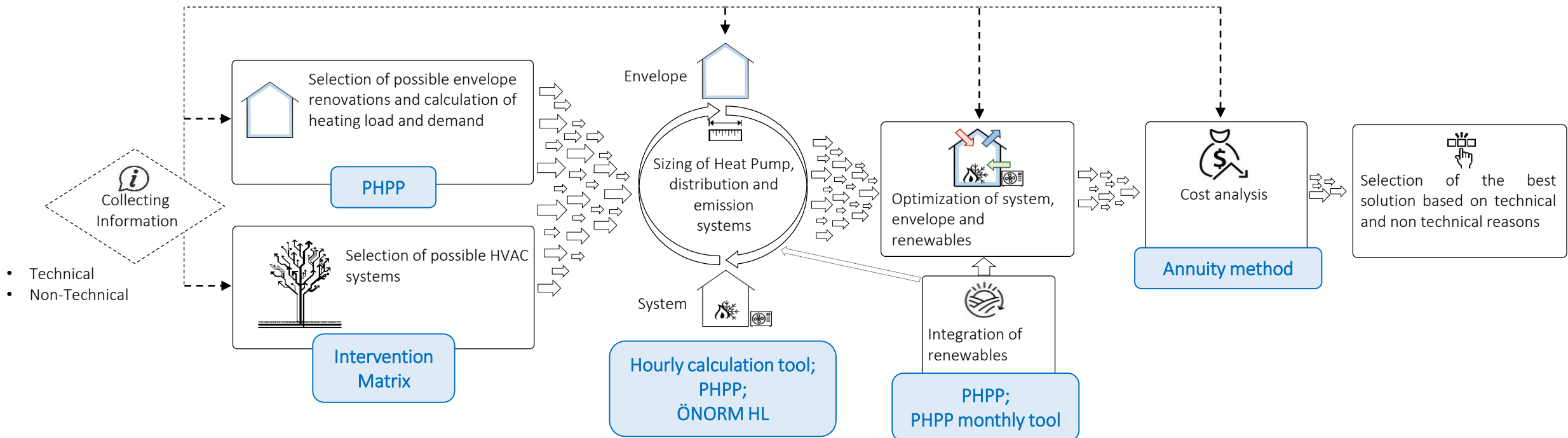
Framework of the project: **RENEWnow** - New impulses for the highly efficient energetic renovation of multi-storey buildings and districts



Methodology



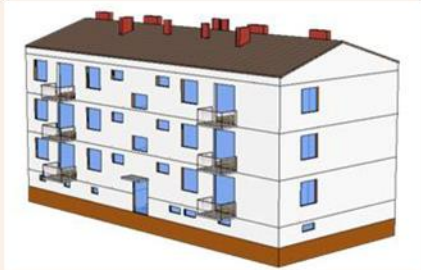

Methodology

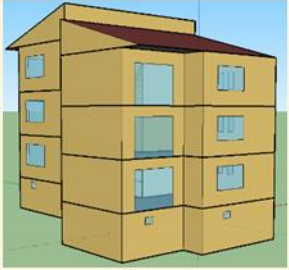





Reference Buildings


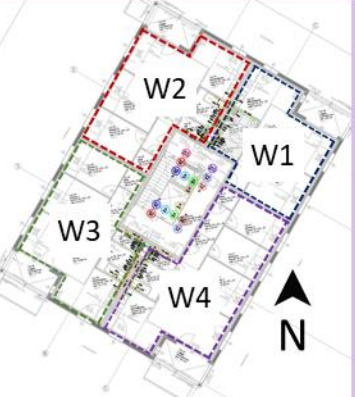
Net floor area [m²]:
 Building foot print [m²]:
 Number of floors [-]:
 Flats per floor [-]:
 Net floor area of the flats [m²]:
 Persons per flat [-]:

	A.	B.	C.	D.
Net floor area [m ²]:	627	365	732	1296
Building foot print [m ²]:	229	152	202	449
Number of floors [-]:	3	3	5	4
Flats per floor [-]:	4	2	2	4
Net floor area of the flats [m ²]:	39/65	59	70	73/98/98/109
Persons per flat [-]:	1/2	1.5	2	2

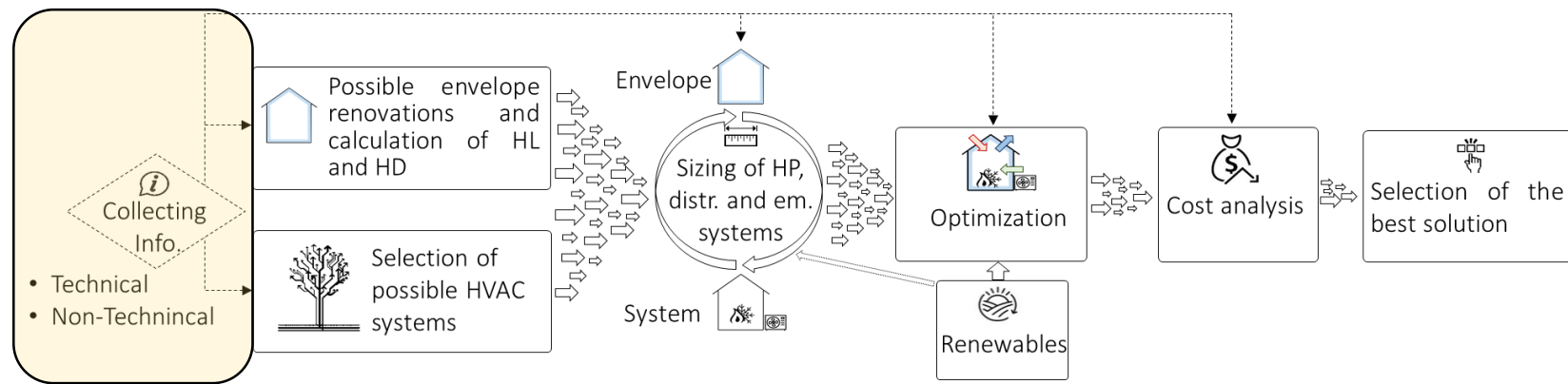



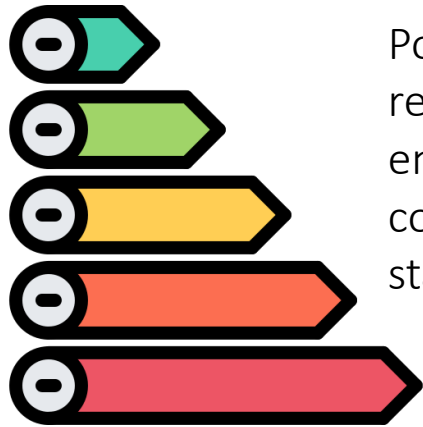
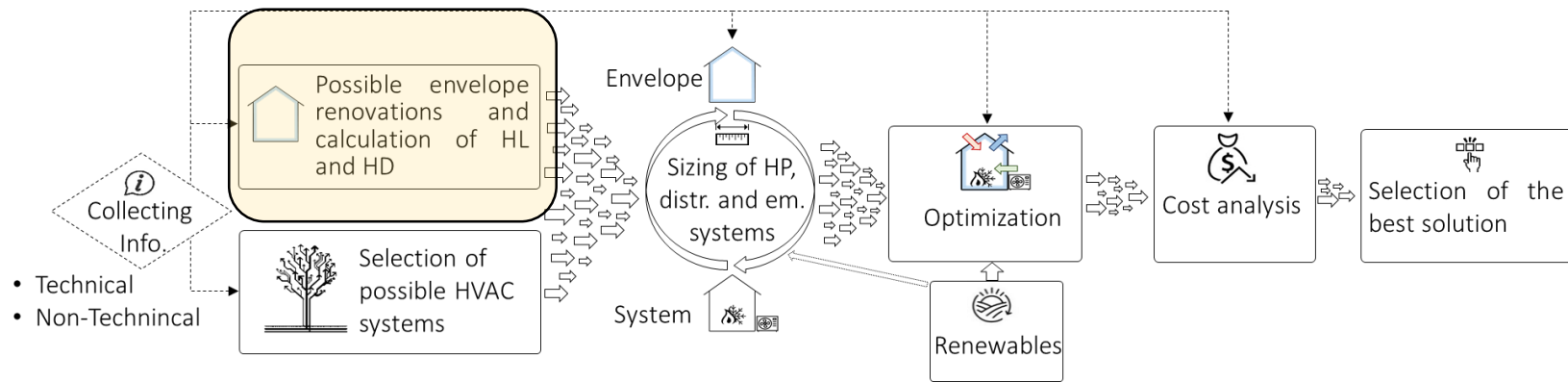



Results: Input data

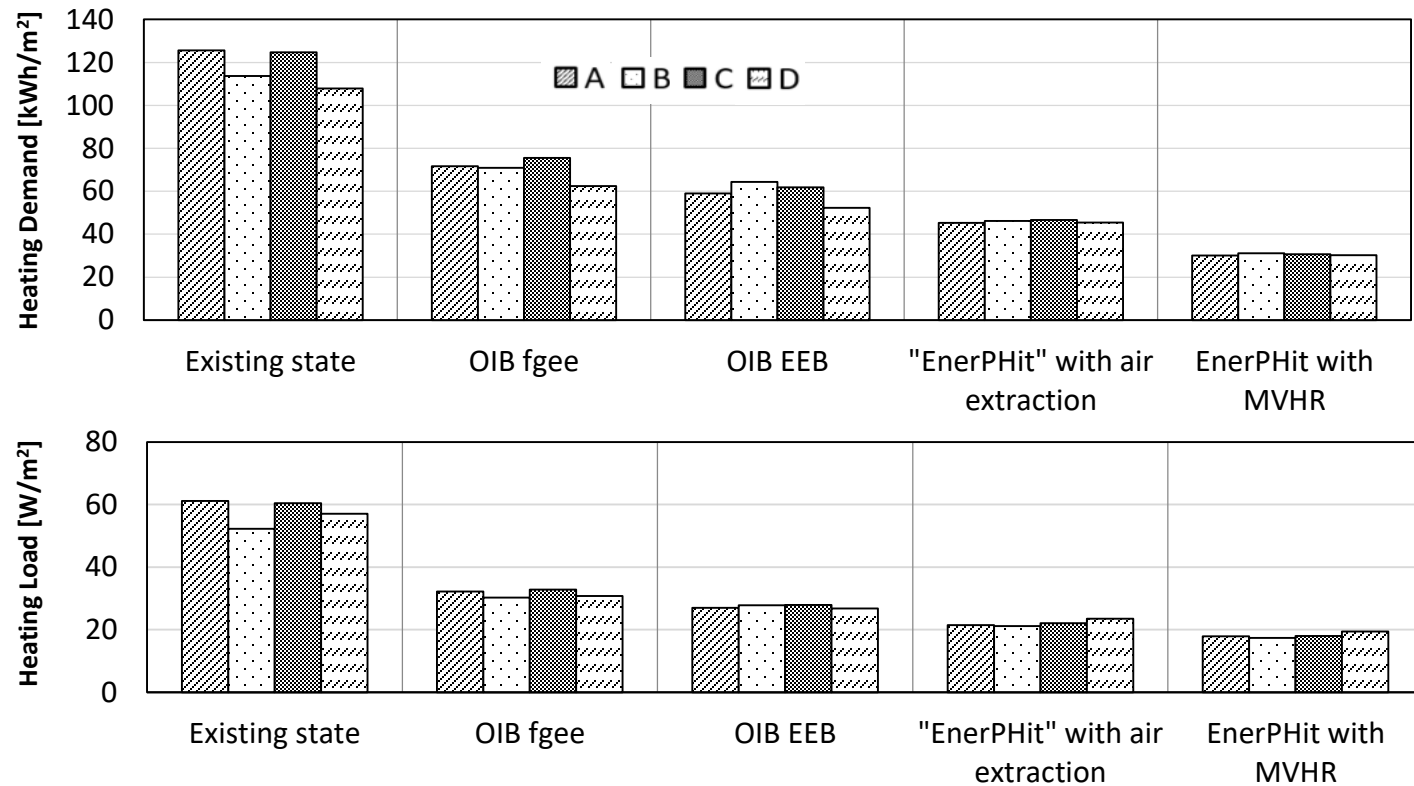


	General	Net area, number of flats, number of floors, floor plans, typology (e.g. multifamily house, row house etc...).
Building	Surroundings	City, suburbs, countryside, distances from neighbours and access roads.
	Quality	Year of construction, constructions materials, insulation level status of the façade and windows.
HVAC	Ventilation	Type and condition of the ventilation system if present.
	Generation	Central, decentral, energy source and status.
	Distribution / emission	Typology and status of emission system, status of the distribution and information about length, diameter and insulation of the pipes.
Space availability		In the flat, attic, cellar, staircase, chimneys, entrance, on the exterior of the building.
Owners		Owner's structure, interest (self living, rental/sale, or investment), goals of the renovation (low investment, reduction of operative cost, etc...), personal preferences.

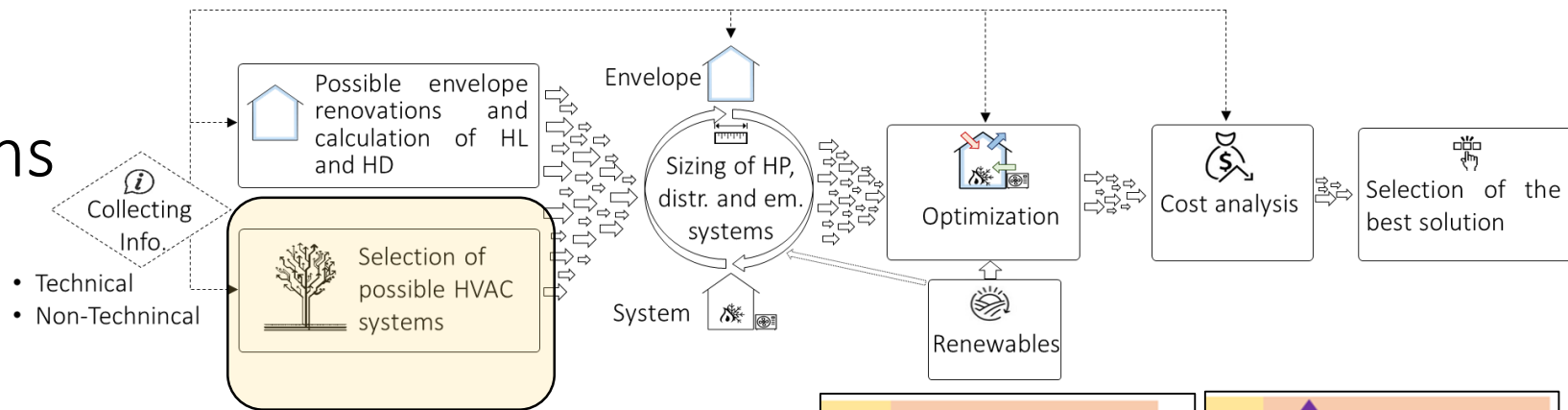
Results: Envelope renovation



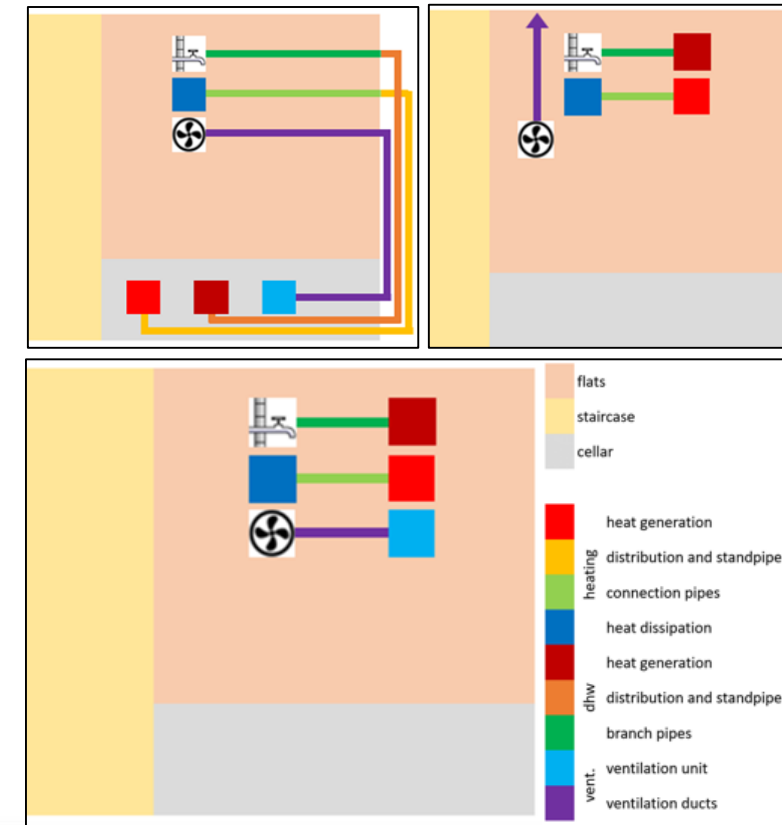
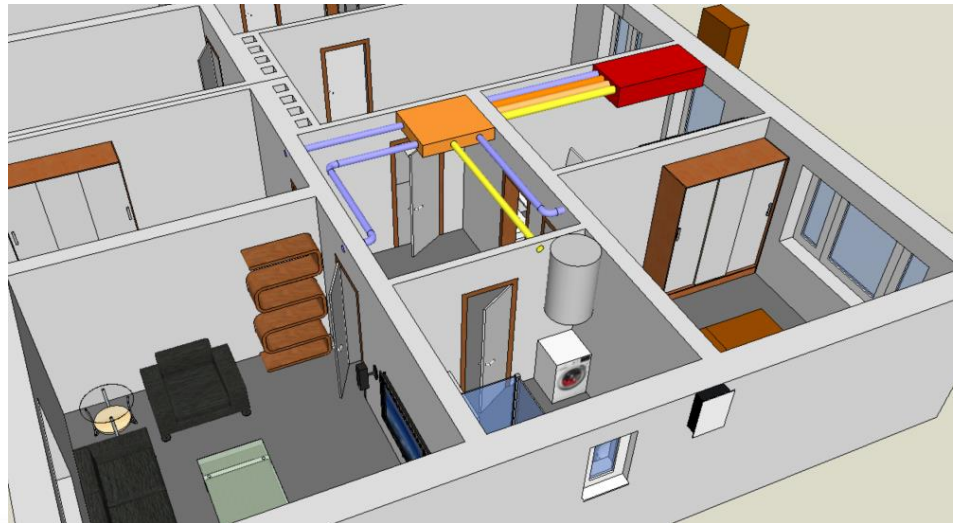
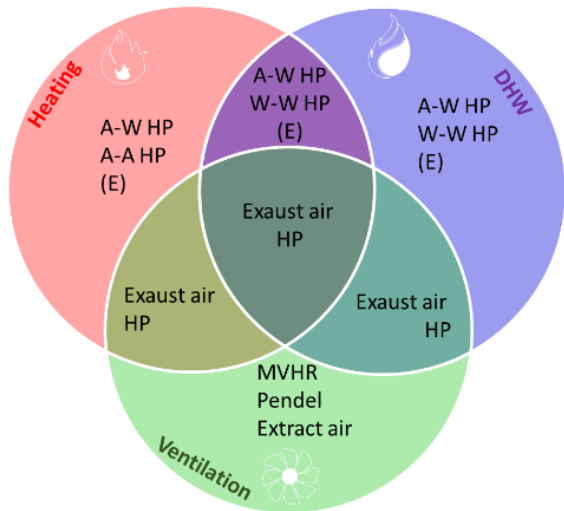
Possible solutions for the renovation of the building envelope are defined considering different standards.



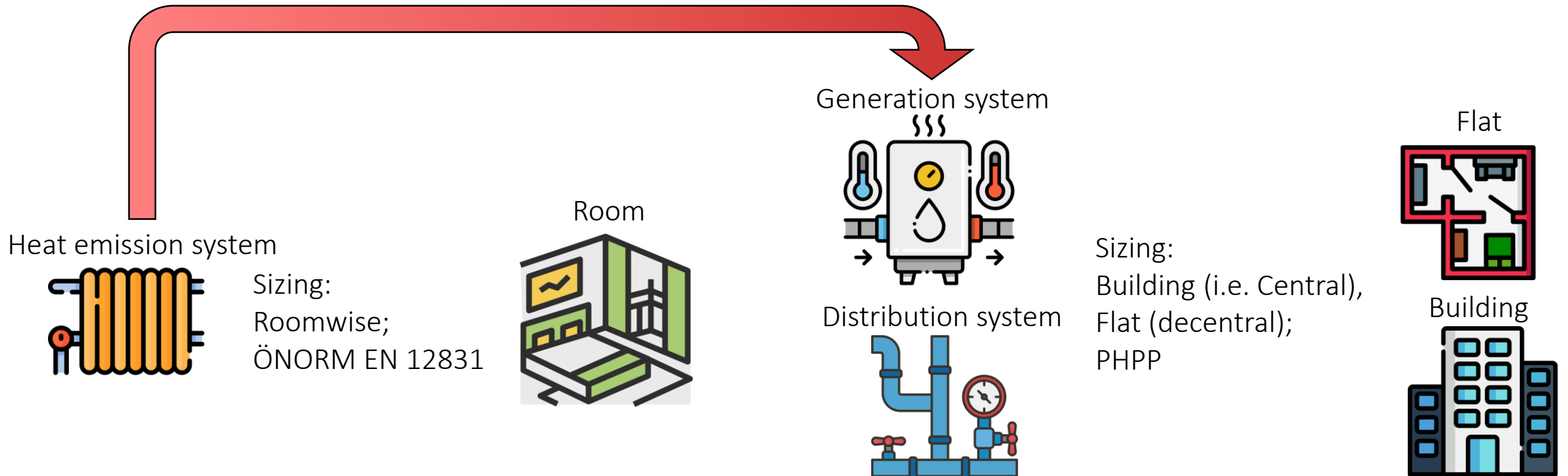
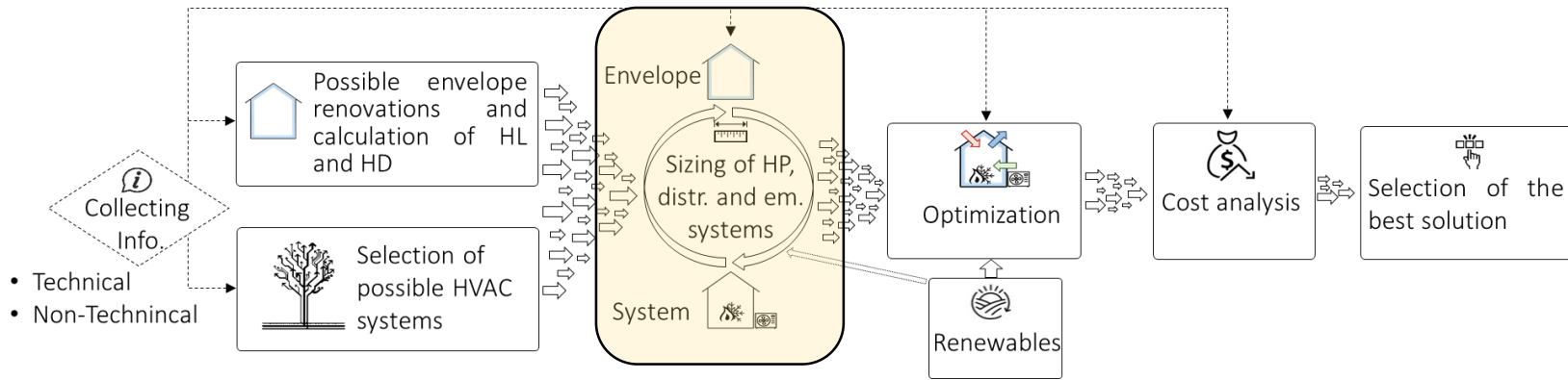
Results: Possible HVAC solutions



Using the information collected in the first step, feasible technical solutions are selected. In this step also innovative solutions (i.e. prefabricated elements hosting also technical equipment, decentral modular solutions) are considered.

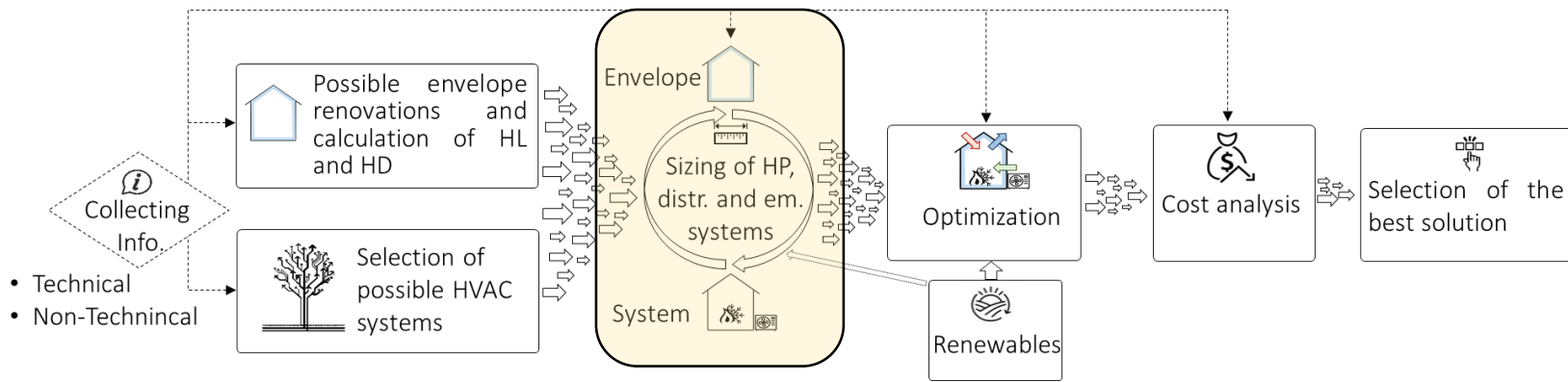


Results: Sizing



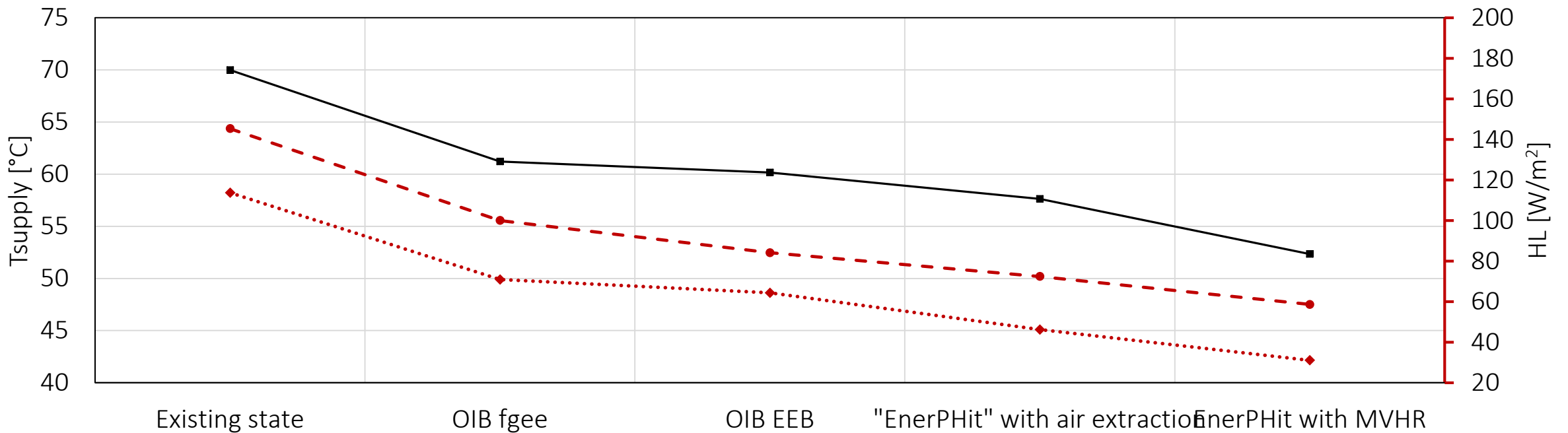
[<https://www.flaticon.com/free-icons/heater> title="heater icons">Heater icons created by Freepik – Flaticon]

Results: Sizing



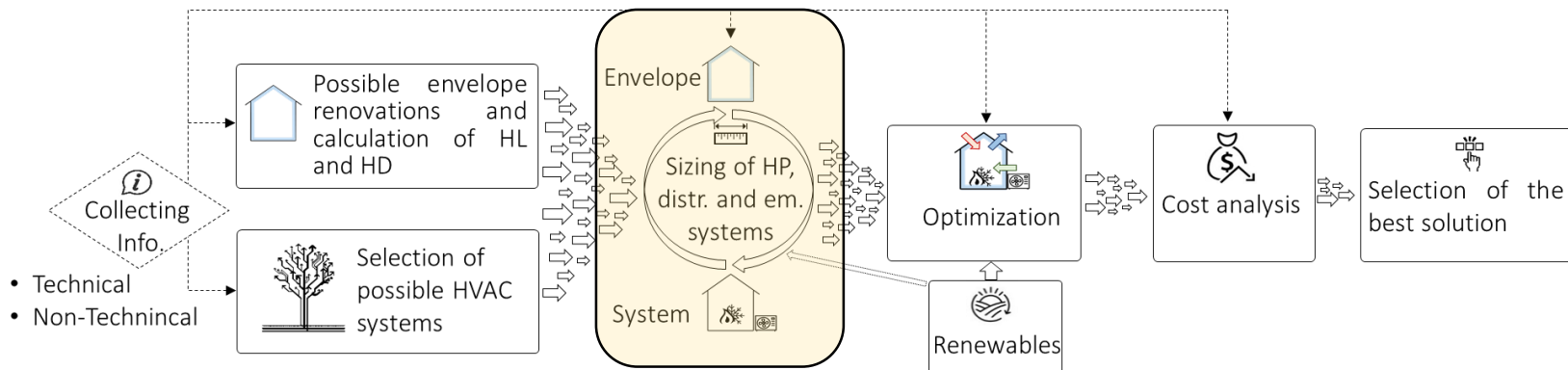
Building B

- T_{supply} max acc. to ÖNORM EN 12831
- - -●- Max room-wise HL calculated acc. to ÖNORM EN 12831
- ...◆... PHPP building HL

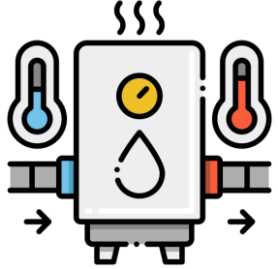


Results: Comparison of distr. systems

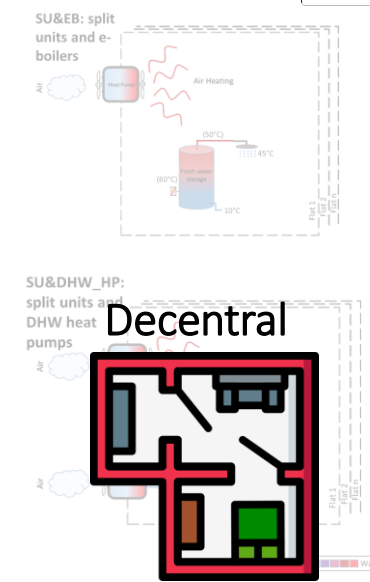
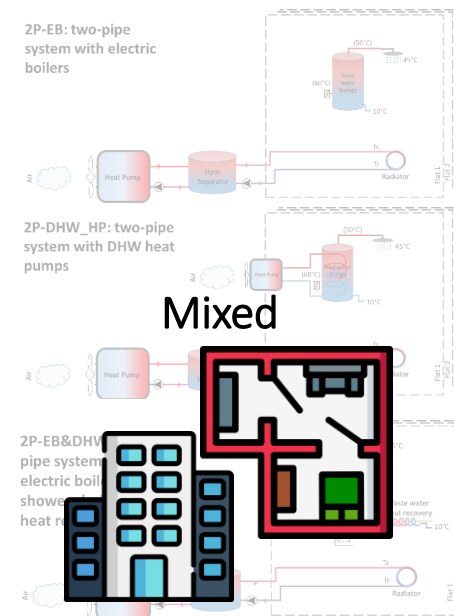
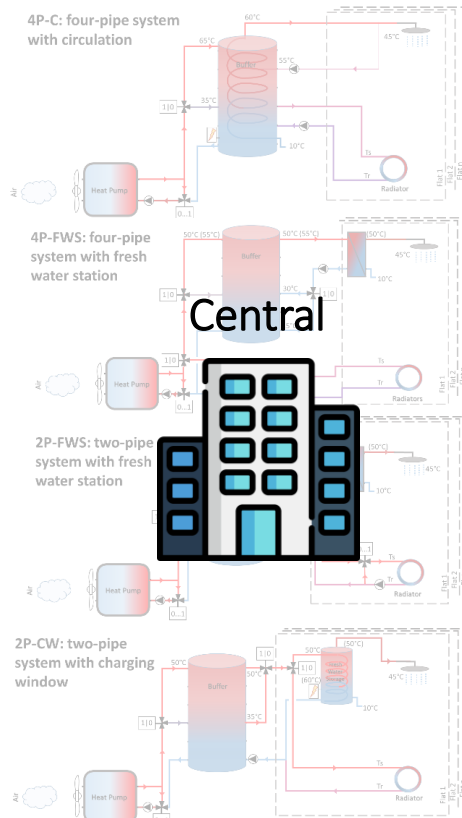
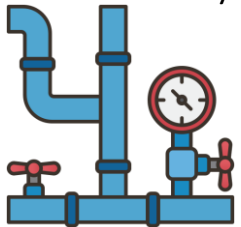
Building D



Generation system



Distribution system



Different building standards

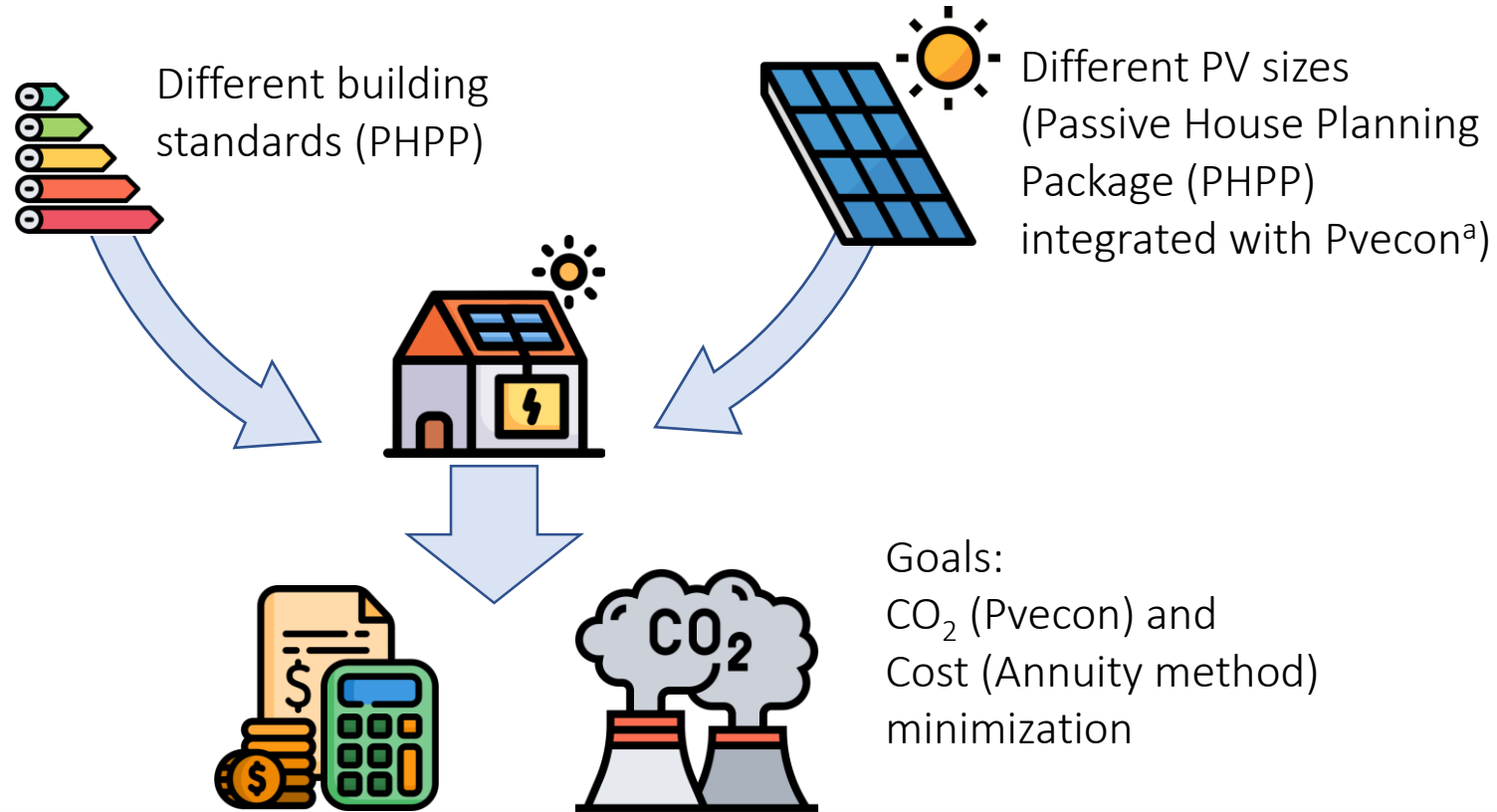
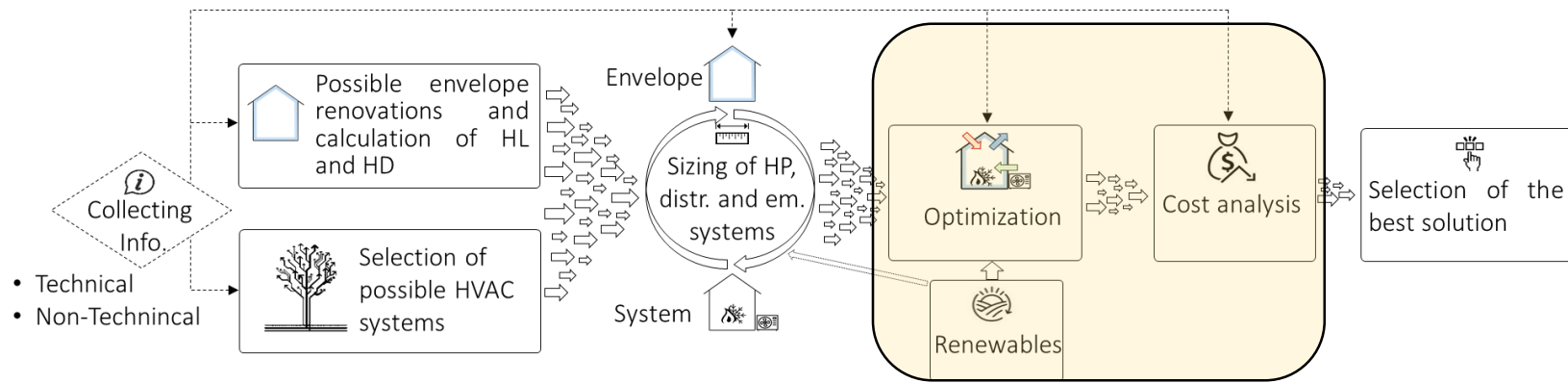
Extending this study (e.g. building geometries, insulation thickness of the pipes, etc..) a wide **benchmark** could be generated that can be used for future decision process

Hourly matlab tool:

- Distribution losses
- Generation efficiency

[Dermentzis, Georgios, Mara Magni, Fabian Ochs, William Monteleone, and Benjamin Schaffer. 2022. "Heat Pump Solutions in Renovations of Multi-Storey Buildings." CLIMA conference, submitted.]

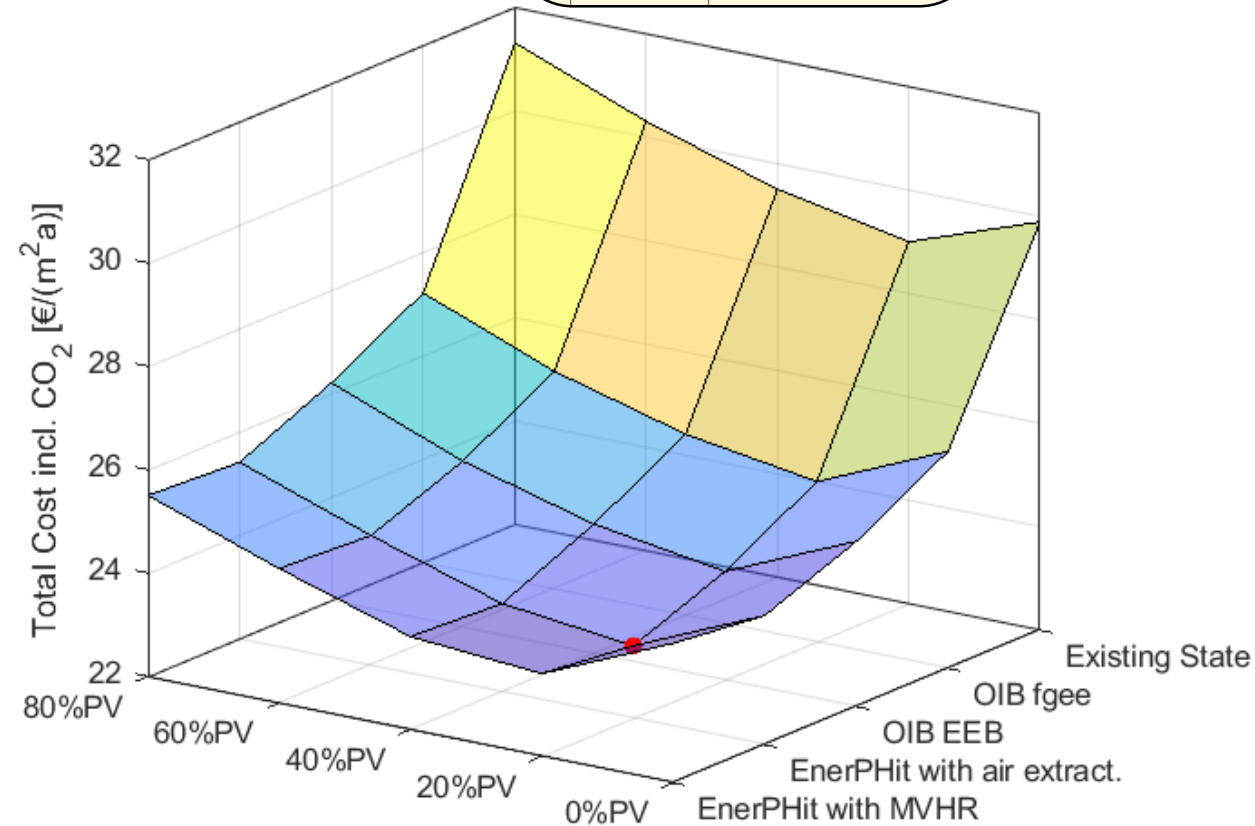
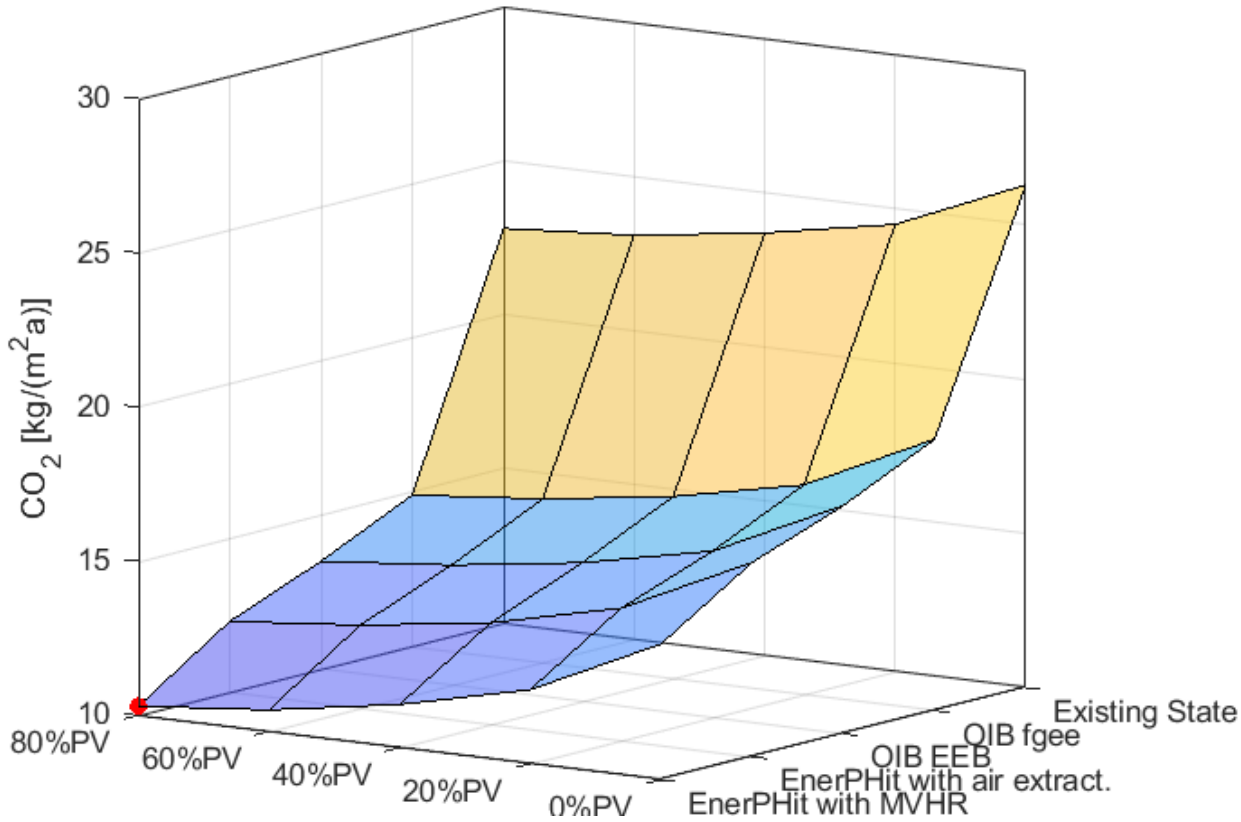
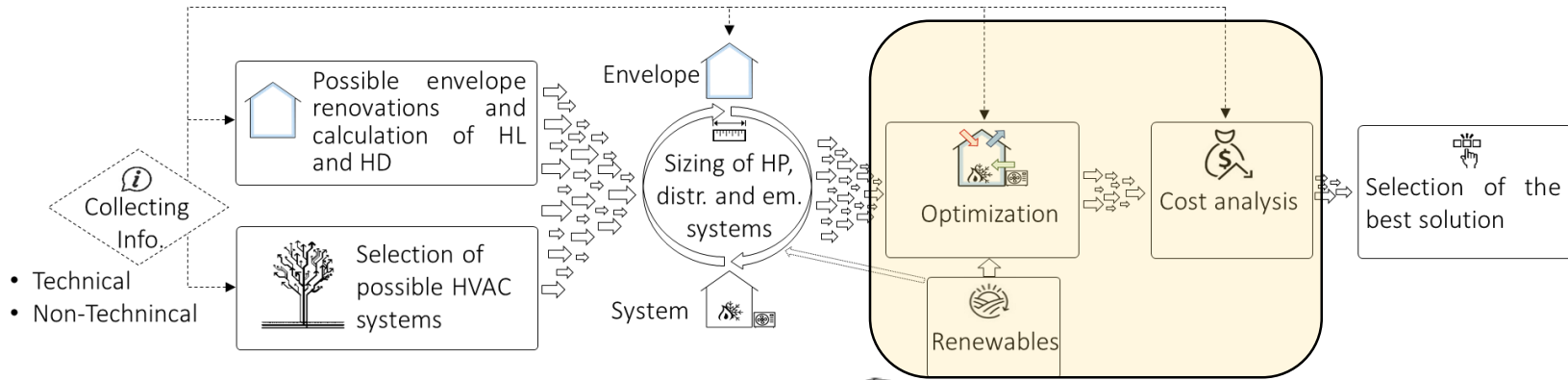
Results: Cost analysis



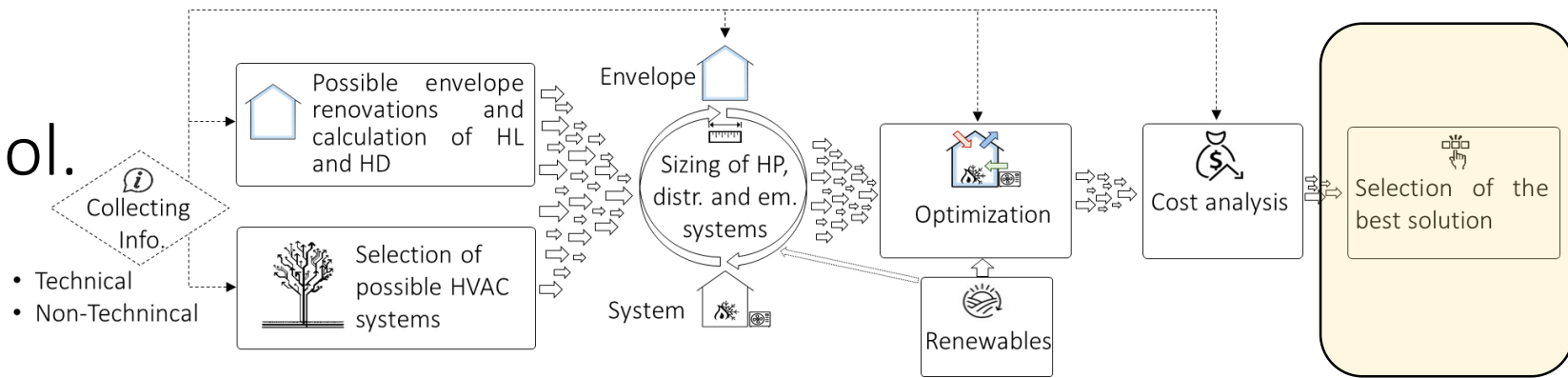
^a IEA SHC Task 56, 2020. PHPP sheet for HP monthly calculation and PV self consumption.

Results: Cost analysis

Building D



Results: Selection of the best sol.



For the selection of the best solution, it is typically important to consider the **technical aspects** introduced in this paper, however, also the **non-technical aspects** (e.g. limits of the investment, priorities and needs of the owners and inhabitants etc...) must be considered.

Conclusions

- A method is developed and tested, to support the planners in the decision process related to the renovation of multi-family houses with a focus on HP applications;
- From the results of the application of the proposed method to the different test cases, it is possible to derive general guidelines;
- The proposed method emphasizes the importance of the combined and coordinated design of the building envelope and HVAC;

Outlook

- In a future work, a single and user-friendly tool able to address all the steps of the proposed method will be created.

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