



Simultaneous Water and Energy Use Improvement in Process Industry

Sustainable Energy Systems

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Introduction

The improvement of water and energy efficiency is an important concern in the context of the most recent sustainable development requirements in the world. In the scope to promote the sustainability of end-use sectors the authors have developed the innovative concept of Water and Energy Integration Systems (WEIS), types of systems to be installed in industry and buildings to promote energy/ water savings and waste mitigation (Castro Oliveira et al., 2022).

In this work, an innovative simulation and optimisation tool designated as ThermWatt set for the modelling and further assessment of WEIS, as part of the elaboration of the PhD work by the author

Methodology

The ThermWatt computational tool is divided into two modules: the main module, which consist in a simulation and dynamic optimisation models library created with the Modelica language, and a complementary module built on the Python language and set for steady-state based optimisation. The tool allows to model each one of the constituent processes of a plant/ building and to obtain estimated sustainability indicator-related results. The rationale behind the tool is summarized in the Figure 1.

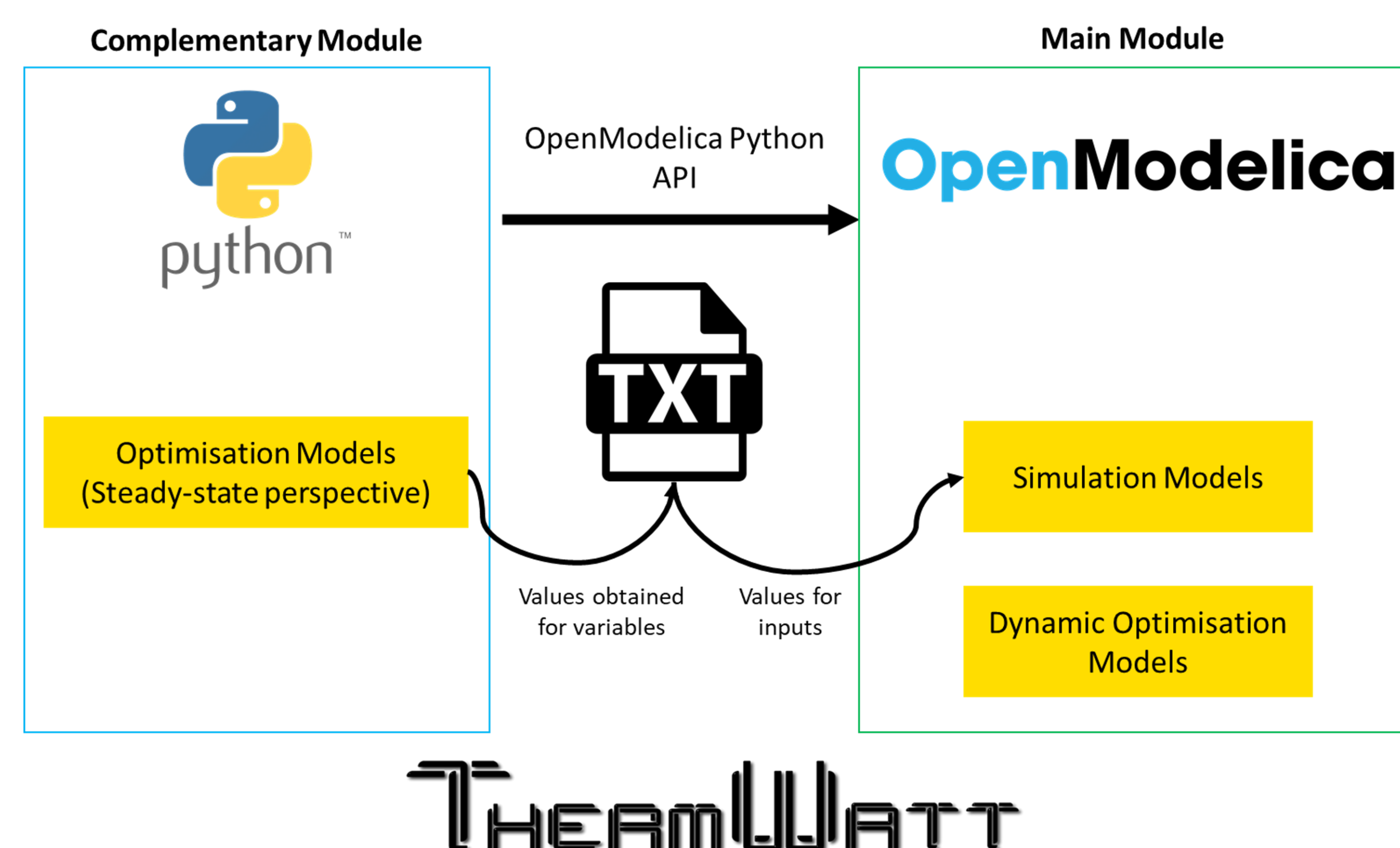


Figure 1. Scheme of the rationale behind the use of the software packages used within the ThermWatt computational tool

Results

A case-study set in a ceramic plant is analysed for the demonstration of the capabilities of the tool.. A general scheme for a proposed system containing the plant processes and the recycling/ reusing of water and energy streams is presented in Figure 2. The final results are presented in Table 1.

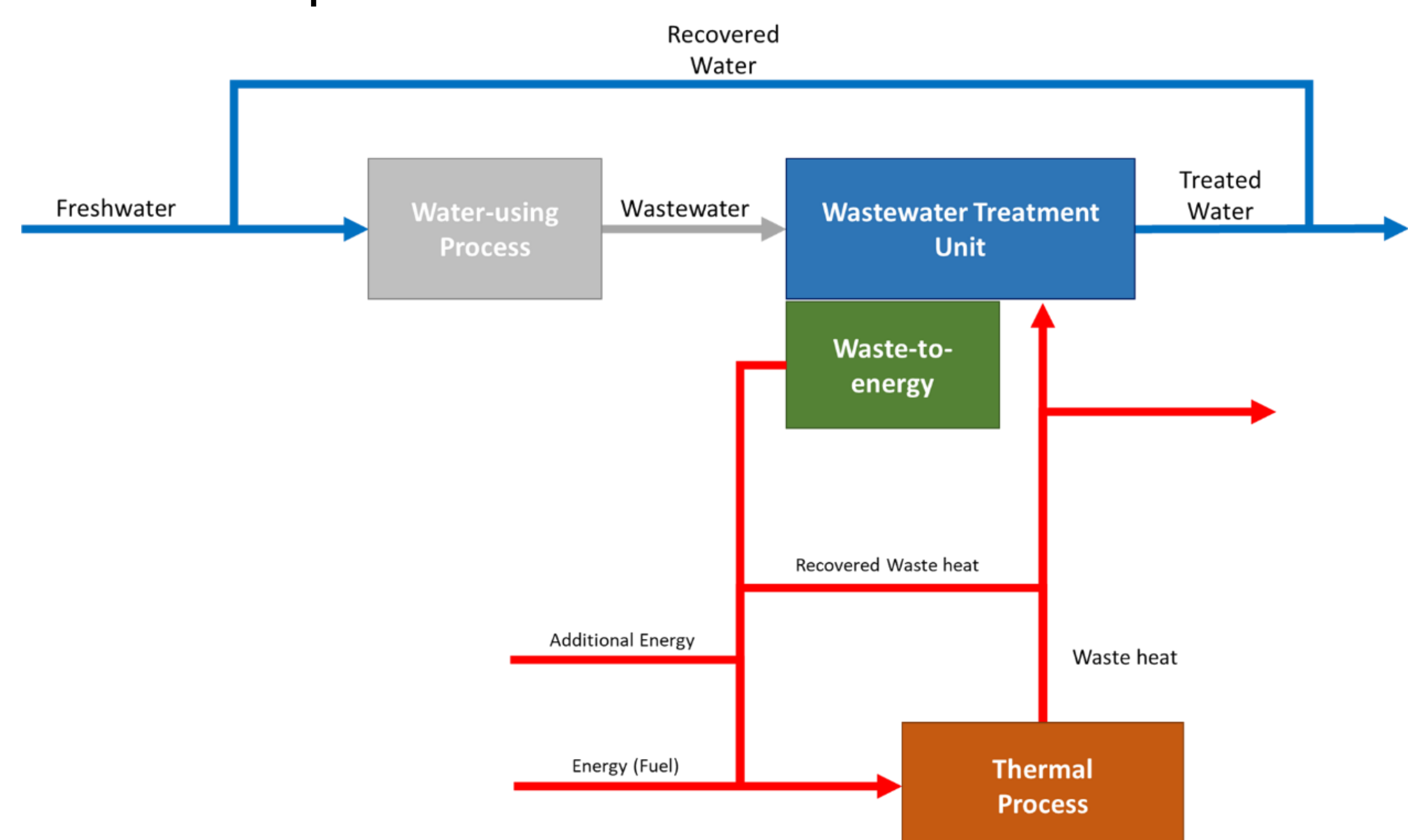


Figure 2. General scheme for a Water and Energy Integration system

Table 1. Sustainability Indicators results

Initial	Improved	Savings (€/h)	
Natural gas consumption (kg/h)			
300.00	227.67 (22.05%)	73.73	
Hot utilities consumption (kJ/h)			
1523880.00	0.00 (100.00%)	36.60	
Cold utilities consumption (kJ/h)			
375914.47	0.00 (100.00%)	16.04	
Water consumption (m³/h)			
1.38	0.98 (28.73%)	0.73	
Final assessment			
Investment Cost (k€)	Savings (k€/year)	Payback Time (Years)	CO _{2,eq} emissions reduction (kton/year)
571.52	990.14	0.58	3.37

Conclusions

A customised tool for the application of the innovative concept of WEIS is presented. To verify the applicability of the concept and the tool, a case-study was analysed. A payback time of 0.58 years was estimated, showing that the tool is able of projecting installations with a high economic viability. A reduction of 2.73 kton CO_{2,eq}/year was estimated, showing a high environmental impact reduction potential.

References

Castro Oliveira M., Iten M., Matos H.A. Review on Water and Energy Integration in Process Industry: Water-Heat Nexus. Sustainability 2022, 14 (3), 7954