The Challenges of Process Integration in Energy, Water, Emissions and Waste Minimisation

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Industrial and residential regions consume large amounts of energy and water. As an unwanted side product produce emission and effluents. They should be evaluated and optimised by applying LCA methodology, which has been recently quantified by environmental footprints as carbon, nitrogen and water footprints.

A considerable research effort has been targeted to improving energy efficiency and it has been shown that heat recovery at the Process Integration Total Site level can provide a high potential for energy savings in industrial, residential, business, services and even agriculture related areas. Total Site Integration offers opportunities for additional heat recovery and cogeneration beside individual processes.

Total Site integration has been an extension of well know methodology known as Process Integration. It modelled and optimised heat and power integration amongst industrial processes. Total Site methodology was extended by including commercial, business, residential users and even agricultures units. This methodology has been extended to serve the scope of regional energy supply and demand networks, integrating energy reuse and renewable sources. Advancing and optimising the design of regional energy networks is expected to contribute to energy savings and footprint reduction with the longer term target of creating energy sustainable regions. An important part of Total Site and regional integrated energy system optimisation is the evaluation of the Environmental impact assessment based on selection, proper combination and evaluation of the environmental related footprints. Footprints is Green house (carbon) footprints, Nitrogen footprints as well as Water footprints have been considered. The aim of this contribution is to present an extension of Total Site integration methodology to be applied to regional energy supplies. Renewable energy sources including solar, wind, biomass and waste, are usually locally available, and on a small scale. Therefore, regional integration is preferable in many cases. A general synthesis model previously developed is extended for the purpose of regional Total Site integration and applied within the demonstration case study.

In order to be able to evaluate the maximal energy savings and footprint reduction within optimally-integrated regional energy networks, a multi-objective, multi-period synthesis is performed accounting for variability of demands and supplies. The model is capable of accounting for various fossil and renewable energy sources, optimising the selection of raw materials, intermediate and final product flows. Timely-optimal planning of energy production and consumption with optimal connecting logistic networks is presented obtained. A demonstration case study illustrates the novel design methodology.

This contribution presents an extension of Total Site integration to regional integration. The use of this synthesis approach simultaneously improves both the energy efficiency and environmental footprints. This approach has been successfully applied within Implementation case study.

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